Appendix G

BART Analysis for
Certain Facilities

ENVIRON

June 13, 2007

Mr. Chris Roberie
Administrator, Air Quality Assessment Division
Louisiana Department of Environmental Quality
602 N. Fifth Street
Baton Rouge, LA 70802

Re: Updated Best Available Retrofit Technology Analysis
Sid Richardson Carbon Company, Ltd., Addis Plant
AI Number 4174

Dear Mr. Roberie:

Enclosed you will find one copy of an updated Best Available Retrofit Technology (BART) analysis prepared by ENVIRON for the Sid Richardson Carbon Company, Ltd. (Sid Richardson) Addis Plant (AI Number 4174). This document, which replaces one submitted to the Louisiana Department of Environmental Quality (LDEQ) in May 2007, has been updated to incorporate changes to the visibility impacts analysis as requested by Ms. Yvette McGehee following her review of the BART modeling protocol. The results of the modeling and the findings of the BART engineering analysis remain unchanged.

We appreciate the LDEQ's assistance with and attention to this matter. Please let us know if you have any questions or need additional information. I may be contacted by telephone at 713.470.6657 or by email at sramsey@environcorp.com.

Regards,

RECEIVED
JUN 20 2007

Steven H. Ramsey, P.E. (Texas), BCEE
Principal Consultant

cc: Mr. Long Nguyen, Sid Richardson Carbon Company, w/ Enclosure (2 copies)

ENVIRON

Best Available Retrofit Technology Analysis

Sid Richardson Carbon Company, Ltd.
Addis, Louisiana, Plant
AI Number 4174

Prepared for:

Sid Richardson Carbon Company, Ltd.
Fort Worth, Texas

Prepared by:

Steven H. Ramsey
Christopher J. Colville

ENVIRON International Corporation

May 2007
Project No. 26-18167A

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1. INTRODUCTION AND BACKGROUND INFORMATION

1.1 Background on Regional Haze

In 1999, the EPA promulgated rules to address visibility impairment – often referred to as "regional haze" – at designated federal Class I areas. These include areas such as national parks and wilderness areas where visibility is considered to be an important part of the visitor experience.[1] There is one Class I area in Louisiana, Breton National Wildlife Refuge, as well as others in surrounding states. Guidelines providing direction to the states for implementing the regional haze rules were issued by EPA in July 2005. Affected states, including Louisiana, are required to develop plans for addressing visibility impairment. This includes a requirement that certain existing sources be equipped with Best Available Retrofit Technology, or BART. Louisiana is required to submit a regional haze plan to EPA no later than December 17, 2007.

1.2 Potentially Affected BART Sources

The Louisiana Department of Environmental Quality (LDEQ) has identified potentially BART-affected sources as those:

- Belonging to one of 26 industry source categories;[2]
- Having the potential to emit (PTE) 250 tons per year or more of any visibility-impairing pollutant;[3] and
- Not in operation prior to August 7, 1962, and in existence on August 7, 1977.

Based on results of a CALPUFF model screening analysis performed by the LDEQ, 28 facilities in Louisiana were identified as potentially BART-eligible. These facilities were sent letters indicating that they should perform detailed CALPUFF screening or refined modeling to determine if they have the potential to significantly impact – impacts of 0.5 delta-deciview (del-dv) or greater – one or more Class I areas. The Sid Richardson Carbon Company Addis Plant is one of these 28 facilities.[4]

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[1] 40 CFR 51, Subpart P

[2] (1) fossil fuel-fired steam electric plants of more than 250 MMBtu/hour heat input; (2) coal-cleaning plants (thermal dryers); (3) Kraft pulp mills; (4) Portland cement plants; (5) primary zinc smelters; (6) iron and steel mill plants; (7) primary aluminum ore reduction plants; (8) primary copper smelters; (9) municipal incinerators capable of charging more than 250 tons of refuse per day; (10) hydrofluoric, sulfuric, and nitric acid plants; (11) petroleum refineries; (12) lime plants; (13) phosphate rock processing plants; (14) coke oven batteries; (15) sulfur recovery plants; (16) carbon black plants (furnace process); (17) primary lead smelters; (18) fuel conversion plants; (19) sintering plants; (20) secondary metal production facilities; (21) chemical process plants; (22) fossil fuel-fired boilers of more than 250 MMBtu/hour heat input; (23) petroleum storage and transfer facilities with capacity exceeding 300,000 barrels; (24) taconite ore processing facilities; (25) glass fiber processing plants; and (26) charcoal production facilities.

[3] *Visibility-impairing air pollutant* is defined in 30 TAC 116.1500((2) as "Any of the following: nitrogen oxides, sulfur dioxide, or particulate matter."

[4] A *deciview* (dv) is a measure of visibility impairment. *Delta-deciview*, or *del-dv* is a measure of visibility impairment relative to natural conditions.

1.3 Source-Specific BART Modeling Results

The Sid Richardson Carbon Company (Sid Richardson) performed source-specific modeling to determine if visibility impacts from their Addis, Louisiana, Plant at one or more Class I areas may be significant. The findings are that the Addis Plant, modeled using actual estimated emission rates, has the potential for significant impacts at one Class I area: Breton National Wildlife Refuge. As required by rule, Sid Richardson must perform an analysis to determine what emission controls, if any, constitute BART for the Addis Plant. This document constitutes Sid Richardson's BART analysis for the Addis Plant.

Results of the refined modeling analysis are included as Attachment A.

2. OVERVIEW OF PLANT OPERATIONS

2.1 General Information

The Sid Richardson Addis Plant is a carbon black manufacturing facility (SIC code 2895, NAICS code 325182) located in Addis, West Baton Rouge Parish, Louisiana. The Plant is located east of Louisiana Highway 1 on Sid Richardson Road about 1 mile south of the town of Addis. Figure 2-1 shows the location of the plant in relation to the town of Addis, Highway 1, and the Mississippi River. Figure 2-2 shows an enlarged image of the Addis Plant. Both images were created using Google Earth.

Figure 2-1. Addis Plant Aerial View 1

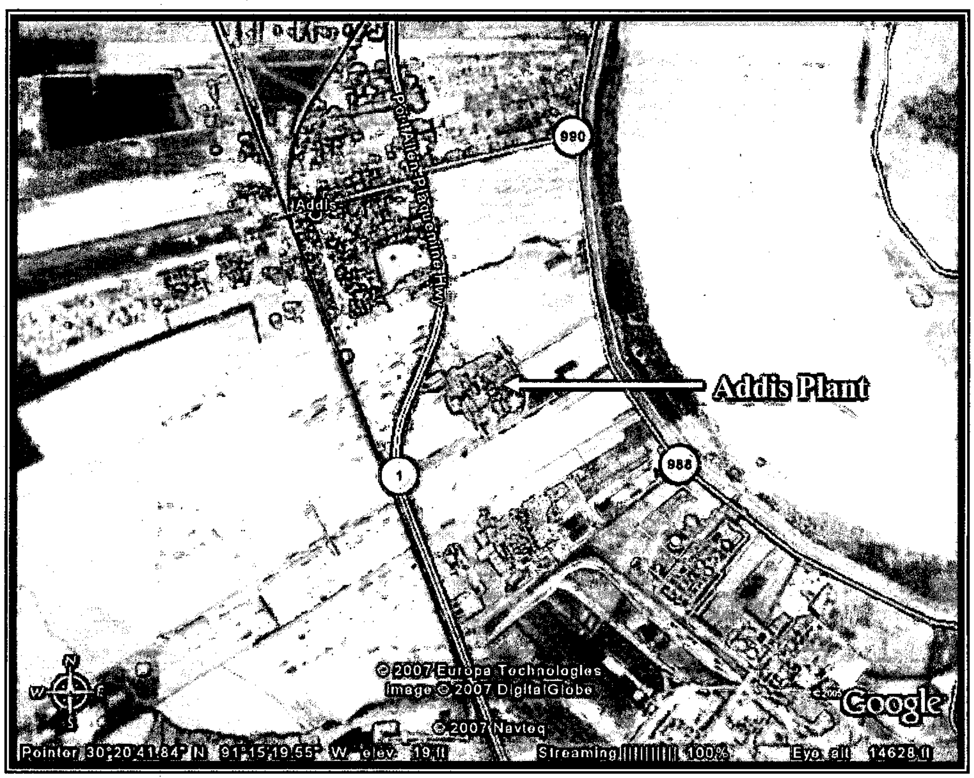
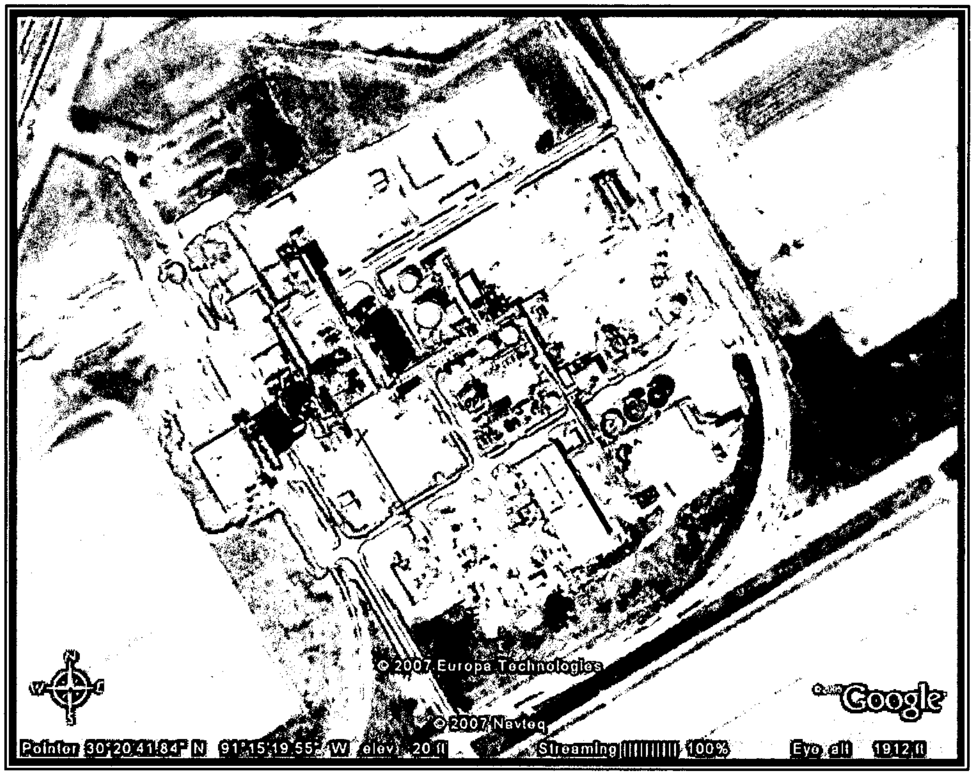


Figure 2-2. Addis Plant Aerial View 2



2.2 Process Description

The Sid Richardson Addis Plant operates three carbon black production process trains designated as Unit 1, Unit 2, and Unit 3. These units produce carbon black by the oil furnace process in four steps: reaction, primary filtering and flaring, pelletizing, and drying.

A process flow diagram for the Addis Plant is presented as Figure 2-3.

Step1. Reaction

Each unit operates with four reactors per reactor train.

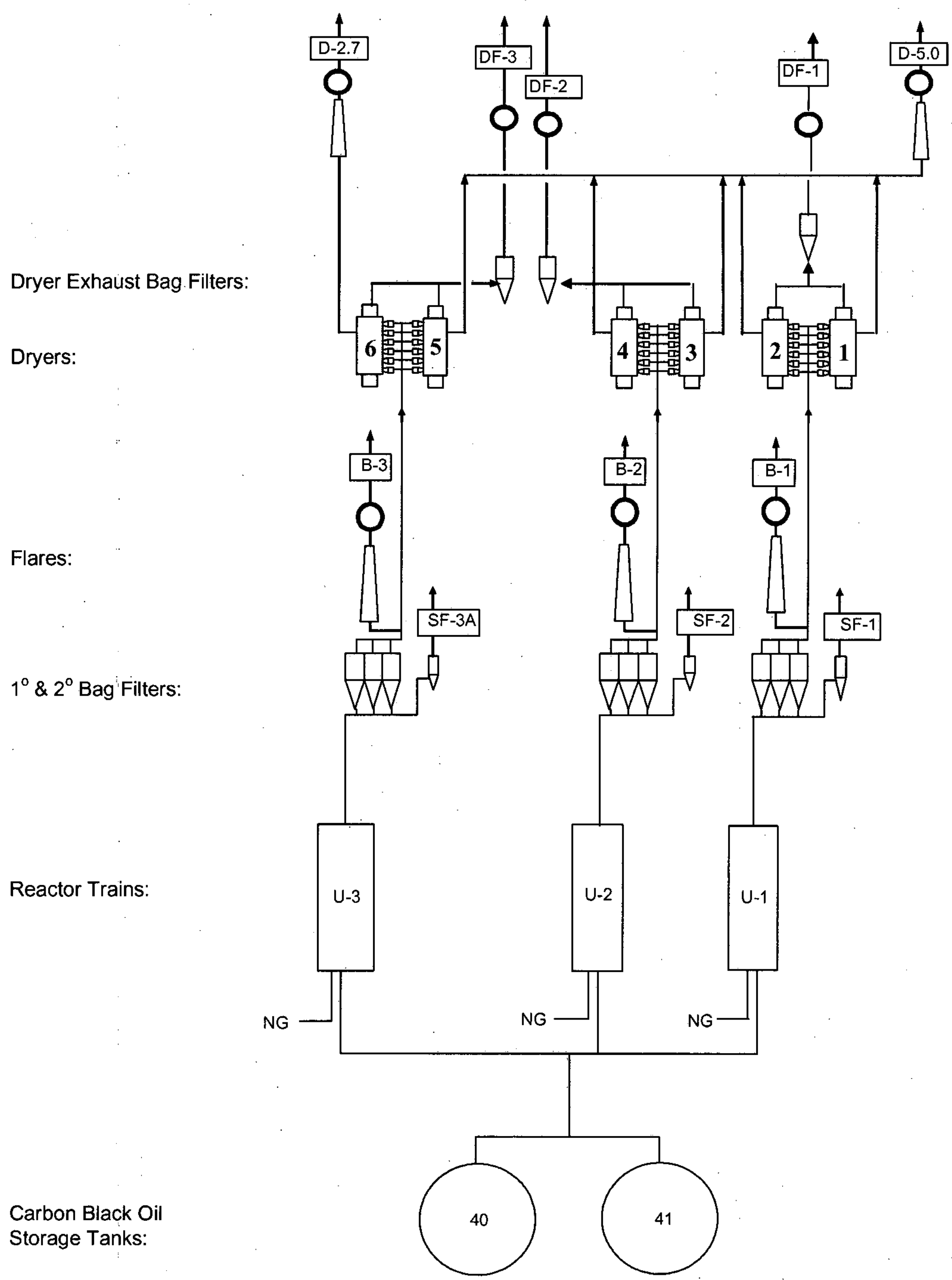
Unit 1: Reactors A, 1, 2 and 3

Unit 2: Reactors 4, 5, 6 and 7

Unit 3: Reactors 8, 9, 10 and 11

With the exception of Reactors A and 11, all reactors are BART-eligible emission units.

Figure 2-3. Addis Plant Process Flow Diagram



In each reactor, natural gas or fuel oil is combusted with air to produce a hot combustion stream. Carbon black feedstock oil (CBO), containing approximately 3% sulfur, is injected into the hot combustion stream. The oil is thermally cracked, forming an aerosol comprised of very fine solid carbon particles and products of combustion. The carbon and gaseous mixture is called "smoke." Water is injected at the reactors to cool the smoke to 1,000-1,500°F and stop the cracking. The smoke is further cooled to 500°F with heat exchangers and additional quench water.

Step 2. Primary Filtering and Flaring

The smoke from the reaction step enters the primary bag filter (PBF) which separates over 99.9% of the carbon black from the gaseous products of combustion, or tailgas. A portion of the tailgas is used in the drying process. The remaining tailgas is flared and vented to atmosphere through flare stacks B-1, B-2, and B-3.

There was a question of whether the three flares are BART-eligible emission units because they were not built within the 1962-1977 timeframe. Discussions were held with LDEQ personnel on this issue. LDEQ personnel presented an opinion that since the flares are control devices for the reactors and the reactors are BART-eligible, then the flares are also BART-eligible.

Step 3. Pelletizing

The carbon black collected in the PBF is air conveyed to a secondary bag filter (SBF). Over 99.9% of the conveyed black is recovered in the SBF. The SBF stacks are designated SF-1, SF-2, and SF-3A. The carbon black collected in the SBF is fed by gravity to pulverizers and then to pelletizers where the black is mixed with water to form small beads to increase bulk density. The emissions associated with the secondary carbon black conveyance are BART-eligible.

Step 4. Drying

The wet carbon black from the pelletizers is gravity-fed to six, indirect-fired rotary dryers. Dryers 2, 3 and 4 are BART-eligible emission units; whereas Dryers 1, 5 and 6 are not. Tailgas from the primary filtering step is combusted in incinerator-like burners at the dryers to supply heat to dry the wet carbon black pellets. The combustion gases from the dryers are vented to the atmosphere via two stacks, D-2.7 and D-5.0. Only D-5.0 is associated with BART-eligible emission units.

Water evaporated in the dryers contains a small amount of entrained carbon black dust which is collected in the dryer exhaust bag filter (DEBF). Over 99.9% of the entrained carbon black is recovered in the DEBFs. The DEBF stacks are designated DF-1, DF-2 and DF-3. A portion of the emissions associated with DF-1 is BART-eligible while all of the emissions associated with DF-2 are BART-eligible. None of the emissions associated with DF-3 are BART-eligible.

3. BART ANALYSIS

3.1 Regulatory Requirements and Guidance

LDEQ regulations specify that each BART-eligible source shall conduct an analysis of emission control alternatives for all visibility-impairing pollutants. This analysis is to include:

1. Identification of all available, technically-feasible retrofit technologies;
2. Cost analysis for each identified technology;
3. Identification of energy and non-air quality environmental impacts;
4. The degree of visibility improvement in affected Class I areas resulting from the use of the control technology;
5. The remaining useful life of the source; and
6. Any existing control technologies present at the source.

BART determinations are to be made in accordance with 40 CFR 51, Appendix Y and should address all visibility-impairing pollutants. This includes primary particulate matter (PM), nitrogen oxides (NO_X) and sulfur dioxide (SO_2). Regulations and guidance establish no de minimis emission rate below which BART need not be considered.

With two exceptions, the EPA has provided no guidance as to what control technologies, emission limits or cost effectiveness thresholds are BART. The two exceptions are presumptive emission limits published in the Federal Register (70 FR 39135) for BART-eligible coal-fired electric generating units and reference to compliance with Maximum Achievable Control Technology (MACT) under the National Emission Standards for the Control of Hazardous Air Pollutants (NESHAPs) for Source Categories (40 CFR 63) as potentially presumptive BART. As presented within 40 CFR 51, Appendix Y, BART is a ***process*** that leads to an outcome determined by the BART source.

3.2 BART-Eligible Emission Units

The BART-eligible emission units at the Addis Plant are as follows:

- Reactors 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and the associated flares;
- Primary and secondary carbon black conveyance for Units 1, 2 and 3;
- Dryers 2, 3 and 4; and
- Dried carbon black conveyance for Dryers 2, 3 and 4.

Emissions from these BART-eligible emission units are vented to atmosphere through emission points B-1, B-2, B-3, SF-1, SF-2, SF-3A, D-5.0, DF-1 and DF-2. Emission point information is presented in Table 3-1.

Only emissions associated with BART-eligible emission units are presented. Maximum 24-hour actual emissions during normal operation are estimated using 2002 annual production data and emission factors. Production during 2002 was the highest of the period 2001-2003. Since the facility operates continuously with little daily variability, use of average daily emissions should be a reasonable approximation of maximum daily emissions.

As shown, SO_2 is the primary pollutant from BART-eligible emission units at the Addis Plant, constituting approximately 93% of visibility-impairing pollutant emissions.

Table 3-1. Emission Source Information

Emission Point	Flowrate (acfm)	Temperature (°F)	Maximum 24-Hour Actual Emission Rate (lbs/day)		
			NO_X	SO_2	PM_{10}
B-1	39,720	1832	112	9,159	278
B-2	44,890	1832	148	11,278	308
B-3	47,532	1832	116	11,297	406
SF-1	13,996	200	0	0	103
SF-2	13,996	200	0	0	114
SF-3A	22,996	200	0	0	150
D-5.0	124,878	800	663	7,234	378
DF-1	12,299	400	0	0	5
DF-2	10.221	400	0	0	9
		Total:	**1,039**	**38,968**	**1,752**

3.3 Identification of Potentially Available Control Options

3.3.1 Nitrogen Oxides

Broadly there are two approaches to the control of NO_X emissions: modifications to the combustion process that prevent the formation of NO_X and post-combustion controls that remove NO_X from the flue gas. In a 1999 technical bulletin, EPA identifies the following combustion modifications for external combustion sources.[5]

- Less Excess Air (LEA)
- Burners Out-Of-Service (BOOS)

[5] U.S. EPA Office of Air Quality Planning and Standards, *Technical Bulletin: Nitrogen Oxides (NOx), Why and How They Are Controlled*, EPA 456/F-99-006R, November 1999.

- Over Fire Air (OFA)
- Low-NO_X Burners (LNB) and Ultra Low-NO_X Burners (ULNB)
- Flue Gas Recirculation (FGR)
- Water or steam injection
- Reduced air preheat
- Fuel reburning (FR)
- Combustion optimization
- Air staging
- Fuel staging
- Pure oxygen combustion
- Catalytic combustion
- Ultra-low nitrogen fuels
- Non-thermal plasma

In the referenced technical bulletin, EPA identifies the following post-combustion NO_X controls.

- Selective Non-Catalytic Reduction (SNCR)
- Selective Catalytic Reduction (SCR)
- Adsorption and absorption (various configurations)

A description of these various technologies, extracted from the referenced EPA technical bulletin, is included as Attachment B.

Two additional technologies potentially available for the control of NO_X are as follows.

- Non-Selective Catalytic Reduction (NSCR) that uses a three-way catalyst to convert NO_X to nitrogen gas while converting carbon monoxide to carbon dioxide and unburned hydrocarbons into carbon dioxide and water. In industrial settings, NSCR has been used almost exclusively to control emissions from stationary internal combustion engines.
- Wet chemical scrubbers such as Tri-Mer Corporation's Tri-NOx® multi-chemical wet scrubbing system.

3.3.2 Particulate Matter

In a 1998 guidance document, EPA identifies the following control approaches for stationary sources of particulate matter.[6]

- Mechanical separators, including cyclones
- Electrostatic precipitation (wet and dry)
- Fabric filtration (various configurations)
- Wet scrubbing (various configurations)

Additional technologies potentially available for the control of particulate matter emissions include High-Efficiency Particle Air (HEPA) and Ultra-Low Penetration Air (ULPA) filters.

3.3.3 Sulfur Dioxide

In January 2006, Sid Richardson submitted to the LDEQ a permit application that included a detailed Best Available Control Technology (BACT) analysis for SO_2. This analysis, included as Attachment C, provides a listing of potentially applicable control technologies. These include the following.

- SCOSOx
- Adsorption
- Turbosonic adsorption
- FLEXSORB
- Regenerative gas desulfurization
- H_2S removal
- Limestone or caustic scrubbing
- Wet gas scrubbers
- E-LIDS
- Claus
- SNOX
- Sulferox
- Flue gas deacidification

[6] EPA Air Quality Strategies and Standards Division, *Stationary Source Control Techniques Document for Fine Particulate Matter*, EPA-452/R-97-001 October 1998.

3.4 Evaluation of Potentially Available Control Options

3.4.1 Nitrogen Oxides

3.4.1.1 Reactors

As discussed in Section 2.2, carbon black is manufactured by the injection of feedstock oil into the hot combustion gases. This is a direct contact process that has been optimized for the production of carbon black meeting very specific product quality specifications. Since the reaction occurs in an oxygen-starved environment that is not conducive to the production of NO_X, in a sense, the reactors are already configured as "low-NO_X" combustion units. The process is not amenable, however, to combustion modifications that would affect the reaction process and, ultimately, the yield and quality of the carbon black produced. To the best of our knowledge, none of the identified potentially available combustion modification options have ever been employed in a carbon black reactor. For these reasons, implementing combustion modifications for the purpose of preventing the formation of NO_X in the reactors is not considered to be technically feasible.

With respect to SNCR, since the manufacture of carbon black is a direct contact process, injection of the SNCR reagent (urea or ammonia) could affect the yield and quality of the carbon black produced. Additionally, it is likely that the reagent would adsorb to the carbon black and have little or no impact on NO_X emissions. To the best of our knowledge, SNCR has never been used to control emissions from a carbon black reactor. For these reasons, SNCR is not considered to be a technically feasible option for the control of NO_X emissions from the reactors.

To control NO_X emissions from the reactors, SCR units would have to be installed downstream of the PBF serving each unit. In discussions with a sales representative for Haldor Topsoe, a manufacturer of SCR systems, concern was expressed about use of SCR in a carbon black application due to the particulate loading – even after passing through a high efficiency fabric filtration system – and the combustible nature of the particulate. It is reasonable to assume that some of the particulate passing through the bag filters would collect on the SCR catalyst and could ignite, destroying the SCR unit and creating a safety and environmental hazard. To the best of our knowledge, SCR has never been used to control emissions from a carbon black reactor. For these reasons, SCR is not a considered to be a technically feasible option for the control of NO_X emissions from the reactors. NSCR also employs a catalyst and is not considered to be a technically feasible option for the same reasons stated for SCR applications.

As noted, EPA identifies various adsorption and absorption processes as available to control NO_X emissions. These include injection of dry sorbents to produce ammonium nitrate and injection of carbon to adsorb and remove NO_X. Since the combustion gases are already in direct contact with the carbon black produced in the reactors, Sid Richardson is, in practice, already employing carbon adsorption to reduce NO_X emissions. The impact on NO_X emissions, however, is not known.

The remaining potentially available NO_X control option is the use of wet chemical scrubbers such as Tri-Mer Corporation's Tri-NOx® multi-chemical wet scrubbing system. It is our understanding that there are a limited number of industrial applications in actual operation and that there are no wet chemical scrubbers in use at carbon black manufacturing facilities. Therefore, we are of the opinion that this is not a demonstrated technology for the control of NO_X emissions from the reactors.

Based on review of EPA's RACT/BACT/LAER (RBLC) Clearinghouse and knowledge of current emission control practices in the carbon black manufacturing industry, we are of the opinion that the Sid Richardson Addis Plant reactors meet current Best Available Control Technology (BACT) for NO_X.

3.4.1.2 Flares

There are no options currently available for the direct control or elimination of NO_X emissions resulting from the combustion of flare pilot gas. Current BACT is to use pipeline-quality natural gas with low or no fuel nitrogen for the pilot and employ good combustion practices in the operation of the flare. Sid Richardson's flares meet current BACT.

3.4.1.3 Dryers

The rotary dryers were designed by Sid Richardson engineers and built to specification in order to provide a very precise temperature profile for drying the carbon black product. The dryers are fired on high moisture (approximately 40%), low heat content (approximately 70 Btu/ft^3) tailgas that is not amenable to application of traditional combustion modifications. Based upon discussions with Sid Richardson engineers, retrofitting these dryers to employ one or more combustion modification techniques is not feasible. To the best of our knowledge, none of the identified potentially available combustion modification options have ever been employed in a carbon black dryer. For these reasons, combustion modifications are not considered to be technically feasible for the control of NO_X emissions from the dryers.

As with the reactors, there is concern that the carbon black in the flue gas exiting the dryers would adsorb the reagent, rendering an SNCR application ineffective. Additionally, to the best of our knowledge, SNCR has never been used to control NO_X emissions from a carbon black dryer. For these reasons, SNCR is not considered to be a technically feasible option for the control of NO_X emissions from the dryers.

For application of SCR or NSCR to the dryers, there is the same concern about catalyst bed fires identified for the reactors. Additionally, to the best of our knowledge, neither SCR nor NSCR have ever been used to control emissions from a carbon black dryer. For these reasons, SCR and NSCR are not considered to be technically feasible options for the control of NO_X emissions from the dryers.

We are not aware that adsorption and/or absorption processes have ever been used to control NO_X emissions from rotary dryers at carbon black plants. However, as with the reactors (albeit at a much lower concentration), carbon black is present in the flue gas exiting the dryers. Impacts on

NO_X emissions, however, are unknown.

As discussed for the reactors, there are a limited number of wet chemical scrubbers in actual operation and there are none in use at carbon black manufacturing facilities. Therefore, we are of the opinion that this is not a demonstrated technology for the control of NO_X emissions from the dryers.

Based on review of EPA's RBLC Clearinghouse and knowledge of current emission control practices in the carbon black manufacturing industry, we are of the opinion that the Sid Richardson Addis Plant dryers meet current Best Available Control Technology (BACT) for NO_X.

3.4.2 Particulate Matter

Sid Richardson currently employs fabric filters throughout the carbon black manufacturing process to capture product and control particulate matter emissions. These filters operate at vendor-guaranteed performance levels of 99.923% capture efficiency. Of the potentially available control options identified in Section 3.3.2, only HEPA/ULPA filters and certain wet scrubbing technologies potentially offer higher control efficiencies and may have theoretical application as secondary flue gas treatment.

EPA's Air Pollution Control Technology Fact Sheet for HEPA/ULPA filters (EPA-452/F-03-023) identifies current use as limited to specialized applications involving chemical, biological and radioactive particulate matter in low flow situations (less than 2,000 ft^3/min). Clearly this is not the situation for any of the vent streams at a carbon black plant and, to the best of our knowledge, these filters have never been used in a carbon black manufacturing application. HEPA/ULPA filters are not demonstrated technologies and are not considered to be technically feasible for the control of PM from the reactors or dryers.

A wet scrubbing technique that claims to be highly efficient in the removal of fine particulates – equal to or better than fabric filtration – is the Cloud Chamber Scrubber® licensed to and sold by Tri-Mer Corporation. To the best of our knowledge, there are a limited number of industrial applications in actual operation and there are no Cloud Chamber Scrubbers® in use at carbon black manufacturing facilities. Therefore, we are of the opinion that this is not a demonstrated technology for the control of PM emissions from the reactors or dryers.

Based on review of EPA's RBLC Clearinghouse and knowledge of current emission control practices in the carbon black manufacturing industry, it is our opinion that the Sid Richardson Addis Plant meets current BACT for the control of PM.

3.4.3 Sulfur Oxides

The January 2006 BACT evaluation included as Attachment C, while prepared for the entire Addis Plant, is relevant to the discussion of potential retrofit of BART-eligible emission units. As presented within the BACT evaluation, three potential control approaches are considered technically feasible and evaluated for cost effectiveness. The three technologies considered are caustic scrubbing, wet limestone scrubbing, and

Haldor Topsoe's SNOX process. The BACT evaluation contains a detailed cost evaluation for each of these technologies. The conclusion of the BACT analysis is that limiting the sulfur content of the feedstock oil is the only technically and economically feasible option. That limitation is already reflected in the Addis Plant emission limits.

The 2006 BACT analysis recognizes that add-on SO_2 controls have never been considered BACT for carbon black plants and, to the best of our knowledge, no carbon black plant in the United States has ever installed add-on SO_2 controls. Since no add-on SO_2 controls have ever been applied to carbon black manufacturing, they are considered to be undemonstrated for the control of emissions from the reactors and/or dryers.

For the flares, SO_2 emissions are limited by using pipeline-quality natural gas with low sulfur content for the pilot.

Based on review of EPA's RBLC Clearinghouse and knowledge of current emission control practices in the carbon black manufacturing industry, it is our conclusion that the Sid Richardson Addis Plant meets current BACT for the control of SO_2.

3.5 BART Determination

As noted in the discussions of potentially applicable control options, Sid Richardson concludes that the current control regime consisting of:

- Fabric filtration for the control of particulate matter emissions,
- Good combustion control to limit the formation of nitrogen oxides in the dryers, and
- Limiting sulfur in the feedstock oil to limit the formation and emission of sulfur dioxide

constitutes BACT for carbon black manufacturing facilities. In the opinion of Sid Richardson, the existing control regime also constitutes BART. Table 3-2 presents a summary of the BART determination and emissions both before and after implementation of the BART control strategy.

3.6 Change in Emissions of Visibility-Impairing Pollutants

There will be no change in emissions as a result of BART control implementation.

3.7 Change in Visibility Impacts

An evaluation of potential visibility impacts using pre-BART emission rates was performed using CALPUFF in a refined analysis. The analysis is presented in Attachment A. Since Sid Richardson has determined that the existing control approach at the Addis Plant constitutes BART, no emission reductions will result and no improvement in visibility will be realized.

Table 3-2: Summary of BART determination and estimated change in emissions following implementation of BART controls

Emission Point	Associated BART-Eligible Emission Units	BART Control Approach	Pre-BART Emission Rate (lbs/day)			Post-BART Emission Rate (lbs/day)		
			NO_X	SO_2	PM_{10}	NO_X	SO_2	PM_{10}
B-1	Reactors 1, 2, 3 Unit 1 Primary Conveyance Unit 1 Flare	Oxygen-starved combustion for NO_X[1] Fabric Filters for PM[1] Limit sulfur in feedstock for SO_2[1] Limit sulfur in flare pilot for SO_2[1]	112	9,159	278	112	9,159	278
B-2	Reactors 4, 5, 6, 7 Unit 2 Primary Conveyance Unit 2 Flare	Oxygen-starved combustion for NO_X[1] Fabric Filters for PM[1] Limit sulfur in feedstock for SO_2[1] Limit sulfur in flare pilot for SO_2[1]	148	11,278	308	148	11,278	308
B-3	Reactors 8, 9, 10 Unit 3 Primary Conveyance Unit 3 Flare	Oxygen-starved combustion for NO_X[1] Fabric Filters for PM[1] Limit sulfur in feedstock for SO_2[1] Limit sulfur in flare pilot for SO_2[1]	116	11,297	406	116	11,297	406
SF-1	Unit 1 Secondary Conveyance	Fabric Filters for PM[1]	0	0	103	0	0	103
SF-2	Unit 2 Secondary Conveyance	Fabric Filters for PM[1]	0	0	114	0	0	114
SF-3A	Unit 3 Secondary Conveyance	Fabric Filters for PM[1]	0	0	150	0	0	150
D-5.0	Dryers 2, 3, 4	Good combustion practice for NO_X[1]	663	7,234	378	663	7,234	378
DF-1	Dryer 2 Conveyance	Fabric Filters for PM[1]	0	0	5	0	0	5
DF-2	Dryers 3 and 4 Conveyance	Fabric Filters for PM[1]	0	0	9	0	0	9
		TOTAL:	**1,039**	**38,968**	**1,752**	**1,039**	**38,968**	**1,752**

[1]Existing controls

ATTACHMENT A

Refined Visibility Impacts Analysis Performed Using CALPUFF

ENVIRON

Best Available Retrofit Technology Modeling Analysis

Sid Richardson Carbon Company, Ltd.
Addis, Louisiana, Plant
AI Number 4174

Prepared for:

Sid Richardson Carbon Company, Ltd.
Fort Worth, Texas

Prepared by:

Steven H. Ramsey
Christopher J. Colville

ENVIRON International Corporation

June 2007
Project No. 26-18167A

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1. INTRODUCTION

1.1 Purpose

The Sid Richardson Carbon Company (Sid Richardson) retained ENVIRON International Corporation (ENVIRON) to perform a source-specific Best Available Retrofit Technology (BART) modeling analysis using the CALPUFF model for the Sid Richardson Addis, Louisiana, Plant. The modeling is performed in response to a request from the Louisiana Department of Environmental Quality (LDEQ) dated March 1, 2007. The source-specific BART refined modeling analysis presented within this report follows the modeling protocol submitted by ENVIRON on behalf of Sid Richardson to the LDEQ on April 24, 2007. Ms. Yvette McGehee of the LDEQ provided verbal approval of the protocol during a telephone conservation with Mr. Chris Colville of ENVIRON on Monday, May 6, 2007. The modeling protocol followed LDEQ and Central States Regional Air Planning Association (CENRAP) guidance.[1,2] The approved modeling protocol is included as Attachment A.1 to this report.

1.2 Background information

In 1999, the EPA promulgated rules to address visibility impairment – often referred to as "regional haze" – at designated federal Class I areas. These include areas such as national parks and wilderness areas where visibility is considered to be an important part of the visitor experience.[3] There is one Class I area in Louisiana, Breton National Wildlife Refuge, as well as others in surrounding states. Guidelines providing direction to the states for implementing the regional haze rules were issued by EPA in July 2005. Affected states, including Louisiana, are required to develop plans for addressing visibility impairment. This includes a requirement that certain existing sources be equipped with Best Available Retrofit Technology, or BART. Louisiana is required to submit a regional haze plan to EPA no later than December 17, 2007.

1.3 Potentially Affected Sources

The LDEQ has identified potentially BART-affected sources as those:

- Belonging to one of 26 industry source categories;[4]

---

[1] Louisiana Department of Environmental Quality (LDEQ). 2007. *Best Available Retrofit Technology Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana.*

[2] Alpine Geophysics, LLC.2005. *CENRAP BART Modeling Guidelines.*

[3] 40 CFR 51, Subpart P

[4] (1) fossil fuel-fired steam electric plants of more than 250 MMBtu/hour heat input; (2) coal-cleaning plants (thermal dryers); (3) Kraft pulp mills; (4) Portland cement plants; (5) primary zinc smelters; (6) iron and steel mill plants; (7) primary aluminum ore reduction plants; (8) primary copper smelters; (9) municipal incinerators capable of charging more than 250 tons of refuse per day; (10) hydrofluoric, sulfuric, and nitric acid plants; (11) petroleum refineries; (12) lime plants; (13) phosphate rock processing plants; (14) coke oven batteries; (15) sulfur recovery plants; (16) carbon black plants (furnace process); (17) primary lead smelters; (18) fuel conversion plants; (19) sintering plants; (20) secondary metal production facilities; (21) chemical process plants; (22) fossil fuel-fired boilers of more than 250 MMBtu/hour heat input; (23) petroleum storage and transfer facilities with capacity exceeding 300,000 barrels; (24) taconite ore processing facilities; (25) glass fiber processing plants; and (26) charcoal production facilities.

- Having the potential to emit (PTE) 250 tons per year or more of any visibility-impairing pollutant; and
- Not in operation prior to August 7, 1962, and in existence on August 7, 1977.

Based on results of a CALPUFF model screening analysis performed by the LDEQ, 28 facilities in Louisiana were identified as potentially BART-eligible. These facilities were sent letters indicating that they should perform detailed CALPUFF screening or refined modeling to determine if they have the potential to significantly impact – impacts of 0.5 deciview (dv) or greater – one or more Class I areas. [5] The Sid Richardson Addis Plant is one of these 28 facilities.

[5] A *deciview* (dv) is a measure of visibility impairment.

2. CALPUFF MODELING APPROACH

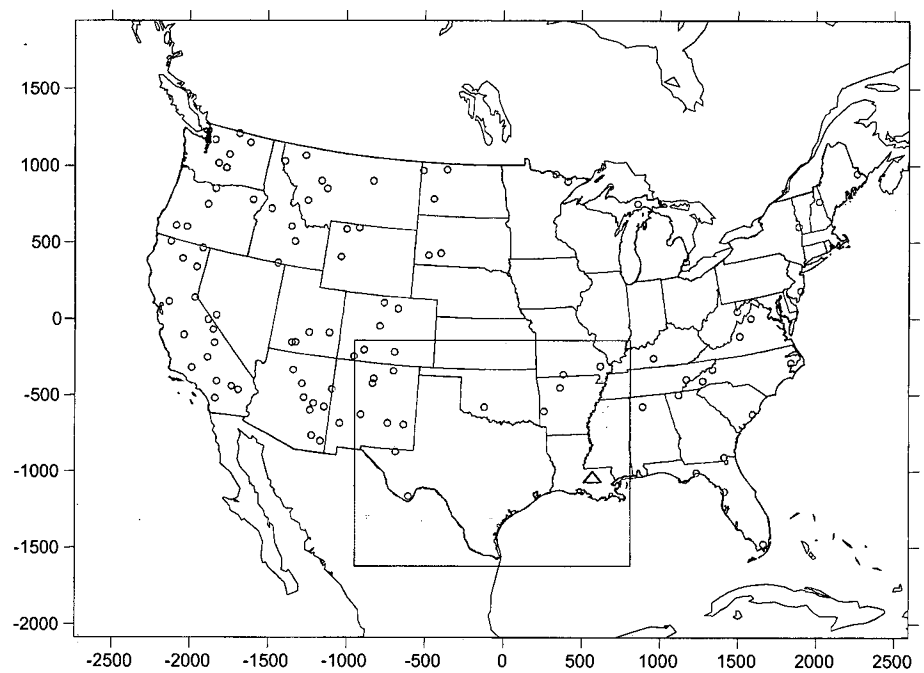
2.1 Overview

One of the air quality modeling approaches in EPA's BART guidance is an individual source attribution approach. Specifically, this entails modeling source-specific BART-eligible units and comparing modeled impacts to the deciview threshold. The modeling approach discussed here is specifically designed for conducting a source-specific BART refined modeling analysis.

2.2 Class I Areas to Assess

Figure 2-1 shows the location of the CENRAP South Domain (yellow box), Class I areas (red circles) and the Addis Plant (green triangle). Lambert Conformal Projection (LCP) coordinates are shown.

Figure 2-1. CENRAP South Domain



The Sid Richardson Addis Plant is located approximately 234 km from Breton National Wildlife Refuge (BRET1), the closest Class I Area. There are no other Class I Areas located within 300 km of the Addis Facility. The next closest Class I Area is the Caney Creek Wilderness Area in Arkansas (CACR1), which is located approximately 518 km from the Addis Plant. As agreed to by the LDEQ, the refined modeling analysis performed for the Sid Richardson Addis Plant is limited to Breton and Caney Creek.

2.3 Air Quality Model and Inputs

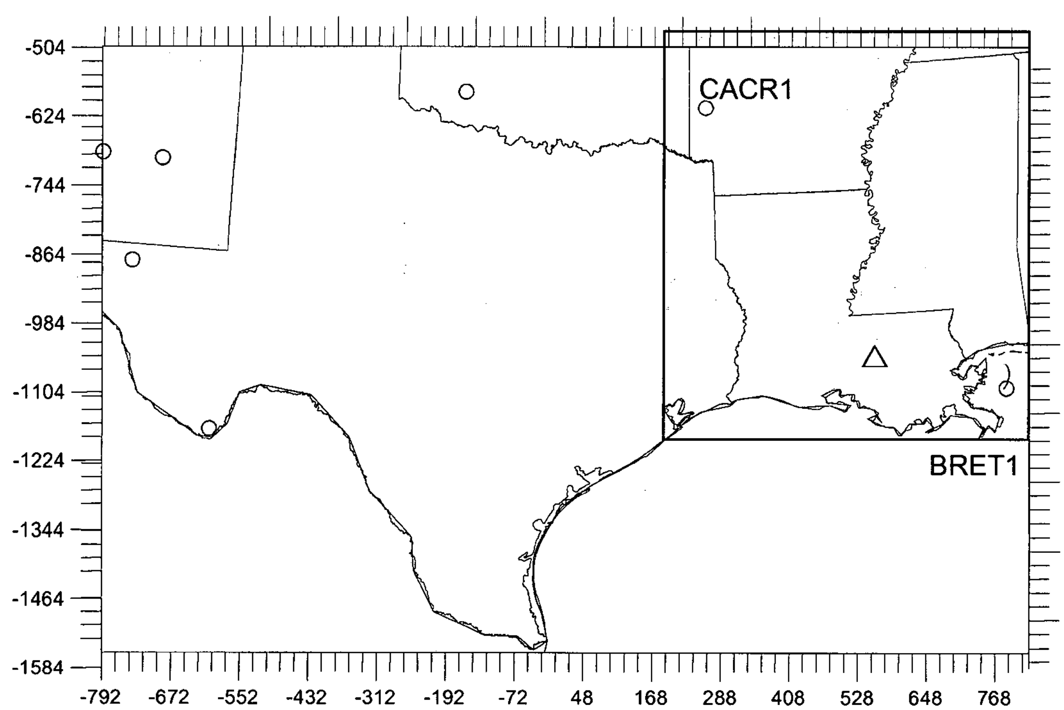
2.3.1 Modeling Domains

The CALPUFF refined modeling analysis is conducted on a portion of the CENRAP south domain, using 6 km grid spacing. The domain extends at least 50 km to the east and south of the Breton National Wildlife Refuge and at least 50 km to the north and west of the Caney Creek Wilderness Area. The domain extents are as follows (Lambert Conformal Projection Coordinates):

- SW Corner (1,1): 180.0 km, -1188.0 km
- NX, NY: 108, 120
- DX, DY: 6 km, 6 km

Figure 2-2 shows the location of the CALPUFF refined modeling domain (yellow box), Class I areas (red circles) and the Addis Plant (green triangle). LCP coordinates are shown.

Figure 2-2. CALPUFF Modeling Domain



2.3.2 *CALPUFF System Implementation*

There are three main components to the CALPUFF model:

- Meteorological Data Modeling (CALMET);
- Dispersion Modeling (CALPUFF); and
- Post-processing (POSTUTIL / CALPOST).

Versions of the modeling components that are used in the source-specific subject-to-BART refined modeling analysis for the Sid Richardson Addis Plant are presented in Table 2-1. Note that the following processors are not used in this analysis because the Sid Richardson Addis Plant analysis utilized the existing CENRAP-developed geophysical data file: TERREL, CTGCOMP, CTGPROC, and MAKEGEO. CALMM5 data is provided by CENRAP.

Table 2-1. CALPUFF Modeling Components

Processor	Version	Level
TERREL	3.311	030709
CTGCOMP	2.42	030709
CTGPROC	2.42	030709
MAKEGEO	2.22	030709
CALMM5	2.4	050413
CALMET	5.53a	040716
CALPUFF	5.711a	040716
POSTUTIL	1.3	030402
CALPOST	5.51	030709

2.3.3 *Meteorological Data Modeling (CALMET)*

LDEQ guidance recommends using the 2001-2003 CENRAP-developed CALMET dataset in source-specific subject-to-BART screening analyses. Because observational data is not used in the CALMET outputs developed by CENRAP, the prognostic meteorological dataset from MM5 is not supplemented with surface or upper air observations during the CALMET processing. However, in their review of the draft CENRAP guidelines, both the EPA and Federal Land Managers (FLMs) commented that observations should be used in refined CALPUFF modeling. Since a refined modeling analysis is conducted for the Sid Richardson Addis Plant, observational data is incorporated during CALMET processing. A listing of CALMET control file inputs used in this analysis is presented in Attachment A.2.

The CALMM5 dataset was obtained from CENRAP for use in creating the CALMET outputs. The CALMET outputs consist of 10 vertical layers (11 layer interfaces). The top interface in the CALMET simulation is 4,000 meters. For the Sid Richardson Addis Plant analysis, surface, precipitation, and upper air observational data are incorporated during CALMET processing. Meteorological stations are selected from within the CENRAP south domain. A listing of the surface and precipitation stations is presented in Attachment A.3. Table 2-2 presents the Upper Air Stations to be used in CALMET processing. At a minimum, the upper air data file from each station contains data from mandatory sounding levels.

Table 2-2. Upper Air Stations

Station Name	Initials	Latitude (deg)	Longitude (deg)
Albuquerque, New Mexico	ABQ	35.05 N	106.62 W
Amarillo, Texas	AMA	35.23 N	101.70 W
Brownsville, Texas	BRO	25.90 N	97.43 W
Corpus Christi, Texas	CRP	27.77 N	97.50 W
Del Rio, Texas	DRT	29.37 N	100.92 W
Dodge City, Kansas	DDC	37.77 N	99.97 W
Fort Worth, Texas	FWD	32.80 N	97.30 W
Jackson, Mississippi (Thompson Field)	JAN	32.32 N	90.07 W
Lake Charles, Louisiana	LCH	30.12 N	93.22 W
Midland, Texas	MAF	31.93 N	102.20 W
Norman, Oklahoma	OUN	35.23 N	97.47 W
North Little Rock, Arkansas	LZK	34.83 N	92.27 W
Santa Teresa, New Mexico	EPZ	31.90 N	106.70 W
Shreveport, Louisiana	SHV	32.45 N	93.83 W
Slidell, Louisiana	SIL	30.33 N	89.82 W
Springfield, Missouri (Regional Airport)	SGF	37.23 N	93.40 W

Surface observations from the seven Western Gulf of Mexico National Oceanic and Atmospheric Administration's National Data Buoy Center (NDBC) Buoys are used in CALMET processing. These buoys are listed in Table 2-3.

Table 2-3. NDBC Buoys

Buoy Number	Latitude (deg)	Longitude (deg)
42001	25.90 N	89.67 W
42002	25.17 N	94.42 W
42007	30.09 N	88.77 W
42019	27.91 N	95.36 W
42020	26.96 N	96.70 W
42035	29.22 N	94.40 W
42040	29.18 N	88.21 W

For the Sid Richardson Addis Plant refined BART analysis, CALPUFF was run with three annual simulations spanning the years 2001 through 2003.

2.3.4 Source Parameters

Source parameters required for modeling BART-eligible units are height of the stack opening from ground, inside stack diameter, exit gas flow rate, exit gas temperature, base elevation above sea level, and source location coordinates. Source parameters used in modeling the Sid Richardson Addis Plant are presented in Table 2-4.

Table 2-4. Source Parameters Used in CALPUFF Modeling Analysis

Emission Point	LCP Coordinates		Height (m)	Base Elevation (m)	Diameter (m)	Velocity (m/s)	Temperature (°K)
	X (km)	Y (km)					
B-1	551.8205	-1055.7946	32.5	5.5	1.64	20.0	1273.2
B-2	551.8105	-1055.8021	32.5	5.5	1.72	20.0	1273.2
B-3	551.7696	-1055.8283	32.5	5.5	1.68	20.0	1273.2
D-5.0	551.7880	-1055.7941	60.4	5.5	1.52	32.3	699.8
SF-1	551.7911	-1055.7960	27.3	5.5	0.46	40.2	366.5
SF-2	551.7747	-1055.8099	27.3	5.5	0.46	40.2	366.5
SF-3	551.7377	-1055.8349	26.2	5.5	0.61	37.2	366.5
DF-1	551.7637	-1055.8114	36.6	5.5	0.91	8.8	477.6
DF-2	551.7436	-1055.8114	36.6	5.5	0.70	12.5	477.6

2.3.5 Emission Rates

LDEQ and CENRAP guidance identifies the following priority approach for determining maximum 24-hour actual emission rates to be used in a BART visibility impairment modeling analysis:

1. Continuous emission monitoring (CEM) data;
2. Facility emissions tests;
3. Emission factors;
4. Permit limits; or lastly,
5. Potential to emit.

Only emissions from BART-eligible emission units are included in the evaluation. Sid Richardson provided maximum 24-hour actual emission rate data to ENVIRON for use in the visibility modeling analysis. Maximum 24-hour actual emissions during normal operation are estimated using 2002 annual production data and emission factors. Production during 2002 was the highest of the period 2001-2003. Since the facility operates continuously with little daily variability, use of average daily emissions should be a reasonable approximation of maximum daily emissions.

Species included in the modeling analysis are listed in Table 2-5. For purposes of modeling the Addis Plant, it is conservatively assumed that all particulate matter is PM-fine($PM_{2.5}$). Source Classification Codes (SCC) and output from the Sparse Matrix Operator Kernel Emissions (SMOKE) program are used to further refine the estimate of PM species into sulfate (SO_4), nitrate (NO_3), elemental carbon (EC), organic carbon (OC) and unspeciated fine particulates (PMF). CALPUFF computes concentrations of HNO_3. It is not emitted directly.

Table 2-5. Species Included in BART Refined Modeling Analysis

Species	Modeled	Directly Emitted	Dry Deposited
SO_2	Yes	Yes	Computed-gas
SO_4	Yes	Yes	Computed-particle
NO_X	Yes	Yes	Computed-gas
HNO_3	Yes	No	Computed-gas
NO_3	Yes	Yes	Computed-particle
EC	Yes	Yes	Computed-particle
OC (SOA)	Yes	Yes	Computed-particle
PM-fine ($PM_{2.5}$)	Yes	Yes	Computed-particle
PM-coarse ($PM_{10-2.5}$)	Yes	Yes	Computed-particle

Sid Richardson Addis Plant modeled emission rates are presented in Table 2-6.

Table 2-6. Emission Rates Used in CALPUFF Modeling Analysis

Emission Point	Emission Rate (g/s)[1]								
	SO_2	SO_4	NO_X	HNO_3	NO_3	EC	OC	PMC	PMF
B-1	48.08	0.0000	0.59	0.0000	0.0000	0.0000	1.4526	0.0000	0.0058
B-2	59.19	0.0000	0.78	0.0000	0.0000	0.0000	1.6106	0.0000	0.0065
B-3	59.30	0.0000	0.61	0.0000	0.0000	0.0000	2.1211	0.0000	0.0085
D-5.0	37.97	0.0000	3.48	0.0000	0.0000	0.0000	1.9772	0.0000	0.0079
SF-1	0.00	0.0000	0.00	0.0000	0.0000	0.0000	0.7173	0.0000	0.0029
SF-2	0.00	0.0000	0.00	0.0000	0.0000	0.0000	0.5965	0.0000	0.0024
SF-3	0.00	0.0000	0.00	0.0000	0.0000	0.0000	1.0475	0.0000	0.0042
DF-1	0.00	0.0000	0.00	0.0000	0.0000	0.0000	0.0287	0.0000	0.0001
DF-2	0.00	0.0000	0.00	0.0000	0.0000	0.0000	0.0477	0.0000	0.0002

[1]SO_2 = gaseous sulfur dioxide; SO_4 = particulate sulfate; NO_X = gaseous nitrogen oxides
HNO_3 = gaseous nitric acid; NO_3 = particulate nitrate; EC = particulate elemental carbon
OC = particulate organic carbon; PMC = coarse particulate matter; PMF = fine particulate matter

Particle size parameters are entered in the CALPUFF input file for dry and wet deposition of particles. For the Addis Plant modeling analysis, default values for "aerosol" species (e.g., SO_4, NO_3, and $PM_{2.5}$) of 0.48 μm geometric mass mean diameter and 2.0 μm geometric standard deviation are used.

2.3.6 Dispersion Model (CALPUFF)

CALMET output is used as input to the CALPUFF model. CALMET simulates the effects of meteorological conditions on the transport and dispersion of pollutants from an individual source. In general, the default options are used in the CALPUFF analysis. An exception is the use of puff-splitting in the analysis conducted for the Sid Richardson Addis Plant. A listing of CALPUFF control file inputs is presented in Attachment A.4.

2.3.6.1 Building Downwash

CENRAP guidance recognizes that downwash is important only at short distances (within 20 km) and recommends use of building downwash algorithms for consistency purposes only if the data are available. For the Sid Richardson Addis Plant, downwash data is not readily available and, given the distance to the nearest Class I area (234 km), there is no technical reason to include the effects of building downwash. Therefore, building downwash affects are not included in this analysis.

2.3.6.2 Ozone and ammonia concentrations

Ozone (O_3) and ammonia (NH_3) may be input to CALPUFF as either hourly or monthly background values. Background hourly O_3 concentrations are derived from regional model simulations obtained from LDEQ. NH_3 concentrations are assumed to be temporally and spatially invariant and are fixed at 3 ppb across the entire domain for all months.

2.3.6.3 Receptors

Receptors are locations where model results are calculated and provided in the CALPUFF output files. Receptor locations are derived from the National Park Service (NPS) Class I area receptor database.[6] The receptors are kept at the one (1) km spacing provided by the NPS.

2.3.6.4 Model Output

CALPUFF modeling results are displayed in units of micrograms per cub meter (μg/m^3). CALPUFF output files are post-processed using CALPOST to determine visibility impacts in deciviews.

2.3.7 Post-Processing (CALPOST)

Hourly concentration outputs from CALPUFF are processed using POSTUTIL and CALPOST to determine impacts on visibility. POSTUTIL takes the concentration file output from CALPUFF and recalculates the

[6] http://www2.nature.nps.gov/air/maps/receptors/index.cfm.

nitric acid and nitrate partition based on total available sulfate and ammonia. CALPOST uses the concentration file processed through POSTUTIL, along with relative humidity data, to perform visibility calculations. POSTUTIL and CALPOST control file inputs are listed in Attachments A.5 and A.6, respectively.

Light extinction must be determined in order to calculate visibility. CALPOST has seven methods for computing light extinction. The Addis Plant analysis uses Method 6, which computes extinction from speciated particulate matter with monthly Class I area-specific relative humidity adjustment factors. Relative humidity correction factors [*f*(RH)s] are applied to sulfate and nitrate concentration outputs from CALPUFF. Relative humidity correction factors are obtained from EPA's "Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule."[7] The $PM_{2.5}$ concentrations are considered part of the dry light extinction equation and do not have a humidity adjustment factor. The light extinction equation is the sum of the wet sulfate and nitrate and dry components ($PM_{2.5}$ plus Rayleigh scattering) which is 10 inverse megameters (Mm^{-1}).

Perceived visibility in deciviews is derived from the light extinction coefficient. The visibility change related to background is calculated using the modeled and established natural visibility conditions. For the Sid Richardson Addis Plant evaluation, daily visibility is expressed as a change in deciviews compared to natural visibility conditions. Natural visibility conditions are based on the annual average natural levels of aerosol components at each Class I area taken from the EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule."[8]

To determine whether or not a source may significantly contribute to visibility impairment at a Class I area, in a refined CALPUFF analysis, the 98th percentile (8th highest value in any year) is compared to a threshold value of 0.5 dv. If the 8th highest impacts for each of the three modeled years are less than 0.5 dv, the source is considered to have an insignificant impact on visibility in the Class I area and is exempt from the requirement to perform a BART analysis or install BART controls.

2.3.8 Model Code Recompilation

To ensure compatibility with the CENRAP-developed files, CALMET, CALPUFF, POSTUTIL and CALPOST model codes were recompiled using the Lahey-Fujitsu FORTRAN Express v7.1 compiler after making changes to the respective parameter files as follows (new parameter value provided).

- *CALMET (modified params.met)*
  - MXNX = 306
  - MXNY = 246

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[7] U.S. EPA (September 2003). *Regional Haze: Estimating Natural Visibility Conditions Under the Regional Haze Rule*. EPA-454/B-03-005.

[8] Ibid.

- MXSS = 375
- MXPS = 375
- MXNXP = 228
- NXNYP = 236

• *CALPUFF (modified params.puf):*
  - MXNX = 306
  - MXNXG = 306
  - MXSS = 375
  - MXPUFF = 100500

• *POSTUTIL (modified params.utl):*
  - MXGX = 306
  - MXGY = 246
  - MXSS = 375
  - MXPS = 375

• *CALPOST (modified params.pst):*
  - MXGX = 306
  - MXGY = 246
  - MXSS = 375

Updated executables for each program were created using the Lahey-Fujitsu FORTRAN Express v7.1 compiler following changes to the parameter files. These updated executables were used in this CALPUFF analysis. The updated parameter files are presented in the electronic archive submitted with this modeling analysis.

3. CALPUFF MODELING RESULTS

Table 3-1 presents the results of the refined CALPUFF analysis for the Sid Richardson Addis Plant. These results are presented graphically in Figures 3-1 and 3-2. As shown, the 8th highest value for 2002 is greater than 0.5 dv at Breton. Therefore, it is determined that emissions from the Addis Plant may significantly contribute to visibility impairment at the Breton National Wildlife Refuge. Consequently, Sid Richardson must prepare a BART analysis for the Addis Plant.

Table 3-1. CALPUFF Modeling Results

Day	Class I Area and Year of Meteorological Data					
	Breton NWR, LA			Caney Creek Wilderness, AR		
	2001	2002	2003	2001	2002	2003
1st Highest	1.390	1.198	0.756	0.234	0.280	0.308
2nd Highest	0.976	1.160	0.551	0.203	0.246	0.214
3rd Highest	0.801	0.797	0.428	0.198	0.209	0.207
4th Highest	0.786	0.740	0.416	0.168	0.163	0.205
5th Highest	0.782	0.728	0.401	0.160	0.151	0.153
6th Highest	0.518	0.676	0.373	0.160	0.139	0.151
7th Highest	0.483	0.656	0.341	0.154	0.138	0.150
8th Highest (98th Percentile)	0.418	0.619	0.328	0.147	0.131	0.146

Figure 3-1. CALPUFF Modeling Results, Breton National Wildlife Refuge

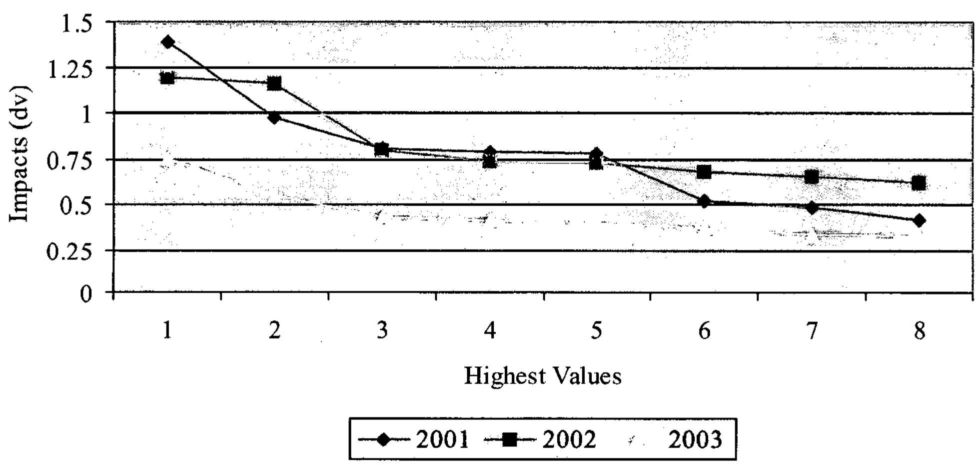
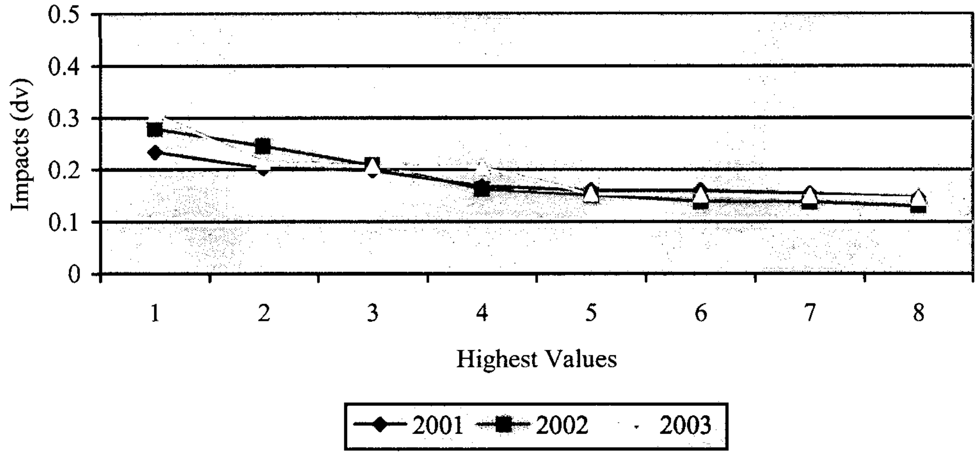


Figure 3-2. CALPUFF Modeling Results, Caney Creek Wilderness Area



An archive of modeling files is included as Attachment A.7. Within the attachment are disks with electronic copies of model input and output files used and created in the modeling analysis. Also included is a table explaining the file naming convention.

ATTACHMENT A.1

Approved Modeling Protocol

DEPARTMENT OF ENVIRONMENTAL QUALITY

KATHLEEN BABINEAUX BLANCO
GOVERNOR

MIKE D. McDANIEL, Ph.D.
SECRETARY

June 4, 2007

Mr. Long Nguyen
Environmental Engineer
Sid Richardson Carbon and Energy
201 Main Street, Suite 3000
Fort Worth, Texas 76102-3131

RE: Protocol for BART refined modeling analysis, Sid Richardson Carbon and Energy, Addis Facility, Addis, West Baton Rouge Parish, Louisiana.

Dear Mr. Nguyen:

The Office of Environmental Assessment, Air Quality Assessment Division, Engineering Group I has no objection to the methodology proposed in the April 24, 2007 modeling protocol submitted by Mr. Christopher Colville for the subject facility. Any deviation from this protocol requires the submittal of an amended protocol and subsequent approval by this Office. LDEQ is requesting that all modeling results and engineering analyses are submitted in writing to the LDEQ by June 15, 2007 and that Buoy data be the observational data used when modeling for Breton.

Please be advised that this approval will expire two months from the date of this letter. As such, a new modeling protocol may be required in the event modeling is not completed within this time frame.

If further questions arise, please contact Yvette McGehee at (225) 219-3537.

Sincerely,

Yvette McGehee

Yvette McGehee
Environmental Chemical Specialist

ym

ENVIRONMENTAL ASSESSMENT
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BEST AVAILABLE RETROFIT TECHNOLOGY MODELING PROTOCOL
SOURCE-SPECIFIC BART REFINED MODELING ANALYSIS
SID RICHARDSON ADDIS FACILITY

Sid Richardson Carbon Company (Sid Richardson) will be performing a source-specific BART modeling analysis using CALPUFF for the Addis Facility in accordance with the Louisiana Department of Environmental Quality (LDEQ) March 1, 2007 request. The proposed modeling protocol to be used in this source-specific BART refined modeling analysis is contained in this document. The proposed modeling protocol is based on the LDEQ Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana and Central States Regional Air Planning Association (CENRAP) guidance.[1,2]

I. Introduction

In 1999, the EPA promulgated rules to address visibility impairment – often referred to as "regional haze" – at designated federal Class I areas. These include areas such as national parks and wilderness areas where visibility is considered to be an important part of the visitor experience.[3] There is one Class I area in Louisiana – Breton Wilderness Area – as well as a number in surrounding states in close proximity to Louisiana. Guidelines providing direction to the states for implementing the regional haze rules were issued by EPA in July 2005. Affected states, including Louisiana, are required to develop plans for addressing visibility impairment. This includes a requirement that certain existing sources be equipped with Best Available Retrofit Technology, or BART. Louisiana is required to submit a regional haze plan to EPA no later than December 17, 2007.

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[1] Louisiana Department of Environmental Quality (LDEQ). 2007. *Best Available Retrofit Technology Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana.*

[2] Alpine Geophysics, LLC. 2005. *CENRAP BART Modeling Guidelines.*

[3] U.S. Environmental Protection Agency (USEPA). 2005. Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations; Final Rule. Fed. Reg. 40 (July 6):39157. (40 CFR 51, Subpart P)

II. Background

BART guidance identifies potentially affected sources as those:

- Belonging to one of 26 industry source categories;[4]
- Having the potential to emit (PTE) 250 tons per year or more of any visibility-impairing pollutant; and
- Not in operation prior to August 7, 1962, and in existence on August 7, 1977.

Based on results of a CALPUFF model screening analysis performed by the LDEQ, 28 facilities in Louisiana were identified as potentially BART-eligible. These facilities were sent letters indicating that these facilities should perform detailed CALPUFF screening or refined modeling to evaluate if they impact a Class I area by at least 0.5-deciview or more.

III. BART Air Quality Modeling Approach

One of the air quality modeling approaches in EPA's BART guidance is an individual source attribution approach. Specifically, this entails modeling source-specific BART-eligible units and comparing modeled impacts to the deciview threshold. The modeling approach discussed here is specifically designed for conducting a source-specific BART refined modeling analysis.

IV. Class I Areas to Assess

The list of Class I Areas to be included in this refined modeling analysis is presented in Table 1. All listed Class I Areas are located within the CENRAP South CALPUFF Domain.

[4] (1) fossil fuel-fired steam electric plants of more than 250 MMBtu/hour heat input; (2) coal-cleaning plants (thermal dryers); (3) Kraft pulp mills; (4) Portland cement plants; (5) primary zinc smelters; (6) iron and steel mill plants; (7) primary aluminum ore reduction plants; (8) primary copper smelters; (9) municipal incinerators capable of charging more than 250 tons of refuse per day; (10) hydrofluoric, sulfuric, and nitric acid plants; (11) petroleum refineries; (12) lime plants; (13) phosphate rock processing plants; (14) coke oven batteries; (15) sulfur recovery plants; (16) carbon black plants (furnace process); (17) primary lead smelters; (18) fuel conversion plants; (19) sintering plants; (20) secondary metal production facilities; (21) chemical process plants; (22) fossil fuel-fired boilers of more than 250 MMBtu/hour heat input; (23) petroleum storage and transfer facilities with capacity exceeding 300,000 barrels; (24) taconite ore processing facilities; (25) glass fiber processing plants; and (26) charcoal production facilities.

Table 1 - Class I Areas Evaluated for BART in the CENRAP South CALPUFF Domain

Class I Area	State	Visibility Monitoring Site Name
Breton Wilderness Area	LA	BRET1
Caney Creek Wilderness Area	AR	CACR1

The Addis Facility is located approximately 234 km from Breton Wilderness Area, the closest Class I Area. There are no other Class I Areas located within 300 km of the Addis Facility. The next closest Class I Area is Caney Creek Wilderness Area, which is located 518 km from the facility. For purposes of this BART refined modeling analysis, Sid Richardson will include the Caney Creek Wilderness Area to determine visibility impacts at this distant Class I Area.

V. Air Quality Model and Inputs

According to the final Regional Haze Rule's BART guidance, a source "can use CALPUFF 5.711a or other appropriate model to predict the visibility impacts from a single source at a Class I area." For purposes of this BART refined modeling analysis, Sid Richardson will use CALPUFF 5.711a.

A. Modeling Domain

The CALPUFF refined modeling analysis will be conducted on a subset of the CENRAP south domain. Sid Richardson will use 6 km grid spacing. The domain will extend at least 50 km to the east and south of Breton Wilderness Area and at least 50 km to the north and west of Caney Creek Wilderness Area. Proposed domain extents are as follows (Lambert Conformal Projection Coordinates):

- SW Corner (1,1): 180.0 km, -1188.0 km
- NX, NY: 108, 120
- DX, DY: 6 km, 6 km

CALPUFF will be applied for three annual simulations spanning the years 2001 through 2003.

B. CALPUFF System Implementation

There are three main components to the CALPUFF model:

1. Meteorological Data Modeling (CALMET);
2. Dispersion Modeling (CALPUFF); and
3. Post-processing (CALPOST).

Versions of the modeling components that will be used in the source-specific subject-to-BART refined modeling analysis are presented in Table 2.

Table 2 - CALPUFF Modeling Components

PROCESSOR	VERSION	LEVEL
TERREL	3.311	030709
CTGCOMP	2.42	030709
CTGPROC	2.42	030709
MAKEGEO	2.22	030709
CALMM5	2.4	050413
CALMET	5.53A	040716
CALPUFF	5.711A	040716
POSTUTIL	1.3	030402
CALPOST	5.51	030709

C. Meteorological Data Modeling (CALMET)

LDEQ guidance recommends using the 2001-2003 CENRAP-developed CALMET dataset in source-specific subject-to-BART screening analyses. Because observational data was not used in the CALMET outputs developed by CENRAP, the prognostic meteorological dataset from MM5 was not supplemented with surface or upper air observations during the CALMET processing. However, in their review of the draft CENRAP guidelines, both the EPA and Federal Land Managers (FLMs) commented that observations should be used in refined CALPUFF modeling. Because Sid Richardson is performing a refined modeling analysis, Sid Richardson will incorporate observational data during the CALMET processing.

Sid Richardson will obtain the CALMM5 dataset from CENRAP for use in creating the CALMET outputs. The CALMET outputs will consist of 10 vertical layers (11 layer interfaces). The top interface in the CALMET simulation will be 4,000 meters. Also, Sid Richardson will process surface, precipitation, and upper air observational data for use in CALMET. Meteorological stations will be selected from within the CENRAP south domain. Only those upper air stations in Louisiana, Arkansas and Mississippi that are within the focused domain will be selected for use in CALMET processing.

D. Stack Parameters

Stack parameters required for modeling BART-eligible units are: height of the stack opening from ground, inside stack diameter, exit gas flow rate, exit gas temperature, base elevation above sea level, and location coordinates of the stack.

Because the modeling conducted for BART is concerned with long-range transport, not localized impacts, including the effects of building downwash in the source-specific subject-to-BART screening analysis is not necessary. However, to conduct a more refined modeling analysis, the effects of building downwash may be included. Therefore, Sid Richardson may include the effects of building downwash in this refined modeling analysis.

E. Emissions

Emission rates for the BART analyses follow EPA's BART guidance. The prioritization below will be used to identify the highest 24-hour emission rates for the 2001-2003 period.

1. Continuous Emissions Monitoring data;
2. Facility emissions tests;
3. Emissions factors;
4. Permit limits; or lastly,
5. Potential to emit.

The species that should be modeled and/or emitted in the source-specific subject-to-BART refined analysis are listed in Table 3.

Table 3 - Species Modeled in BART Refined Analysis

Species	Modeled	Emitted	Dry Deposited
SO_2	Yes	Yes	Computed-gas
SO_4	Yes	No	Computed-particle
NO_x	Yes	Yes	Computed-gas
HNO_3	Yes	No	Computed-gas
NO_3	Yes	No	Computed-particle
PM-fine	Yes	Yes	Computed-particle
PM-coarse	Yes	Yes	Computed-particle

Particle size parameters are entered in the CALPUFF input file for dry deposition of particles. The default value for "aerosol" species (e.g., SO_4, NO_3, and $PM_{2.5}$) is 0.48 μm geometric mass mean diameter and 2.0 μm geometric standard deviation. Sid Richardson will use either the default values or site-specific data for the aerosol species.

F. Dispersion Model (CALPUFF)

The CALMET output is used as input to the CALPUFF model, which simulates the effects of meteorological conditions on the transport and dispersion of pollutants from an individual source. In general, the default options will be used in the CALPUFF model for this refined analysis. However, Sid Richardson will employ the puff-splitting option, which splits puffs that become large over greater transport distances.

Ozone and ammonia concentrations

Ozone (O_3) and ammonia (NH_3) can be input to CALPUFF as either hourly or monthly background values. Background hourly O_3 concentrations will be derived from regional model simulations obtained from CENRAP. NH_3 concentrations are assumed to be temporally and spatially invariant and will be fixed at 3 ppb across the entire domain for all months.

Receptors

Receptors are locations where model results are calculated and provided in the CALPUFF output files. Receptor locations will be derived from the National Park Service (NPS) Class I area receptor database.[5] The receptors will be kept at the one (1) km spacing as provided by the NPS.

Outputs

The CALPUFF modeling results will be displayed in units of micrograms per cubic meter ($\mu g/m^3$). CALPUFF outputs will be post-processed to determine visibility impacts.

G. Post-processing (CALPOST)

Hourly concentration outputs from CALPUFF are processed through POSTUTIL and CALPOST to determine visibility conditions. POSTUTIL takes the concentration file output from CALPUFF and recalculates the nitric acid and nitrate partition based on total

[5] http://www2.nature.nps.gov/air/maps/receptors/index.cfm.

available sulfate and ammonia. CALPOST uses the concentration file processed through POSTUTIL, along with relative humidity data, to perform visibility calculations. For the source-specific BART refined modeling analysis, the only modeling results of interest out of the CALPUFF modeling system are the visibility impacts.

Light Extinction

Light extinction must be computed in order to calculate visibility. CALPOST has seven (7) methods for computing light extinction. Sid Richardson will use Method 6, which computes extinction from speciated particulate matter with monthly Class I area-specific relative humidity adjustment factors. The BART refined analysis will apply relative humidity correction factors [*f*(RH)s] to sulfate and nitrate concentration outputs from CALPUFF. Relative humidity correction factors will be obtained from EPA's "Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule."[6] The $PM_{2.5}$ concentrations are considered part of the dry light extinction equation and do not have a humidity adjustment factor. The light extinction equation is the sum of the wet sulfate and nitrate and dry components ($PM_{2.5}$ plus Rayleigh scattering), which is 10 inverse megameters (Mm^{-1})

VI. Visibility Impacts

Perceived visibility in deciviews is derived from the light extinction coefficient. The visibility change related to background is calculated using the modeled and established natural visibility conditions. For the BART refined modeling analysis, daily visibility will be expressed as a change in deciviews compared to natural visibility conditions. Natural visibility conditions will be based on the annual average natural levels of aerosol components at each Class I area, which are taken from the EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule."[7]

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[6] U.S. EPA (September 2003). *Regional Haze: Estimating Natural Visibility Conditions Under the Regional Haze Rule*. EPA-454/B-03-005.
[7] Ibid.

Sid Richardson will process the CALPOST visibility impacts in deciviews in a spreadsheet to calculate the changes in deciviews (del-dv). These del-dv values will be ranked for each of three years at each Class I area. The 98th percentile (8th highest value) in the sorted table will be compared to the contribution threshold (e.g., 0.5 dv). If the source passes the refined analysis because the highest 98th percentile visibility impact is below the contribution threshold of 0.5 dv, then the source is exempt from further BART requirements. However, if the highest 98th percentile visibility impact is at or above the contribution threshold of 0.5 dv, then Sid Richardson will perform a BART engineering analysis, which includes analysis of the change in visibility due to BART controls.

VII. Change in Visibility Due to BART Controls

If necessary, Sid Richardson will perform a BART engineering analysis and establish BART emission limits. Following that, additional CALPUFF modeling will be conducted to establish visibility improvement at Class I areas with BART applied. The post-control CALPUFF simulations will be compared to the pre-control CALPUFF simulation by calculating the change in visibility over natural conditions between the pre-control and post-control simulations.

VIII. Reporting

As required, this modeling protocol for refined CALPUFF modeling is being submitted to the LDEQ for approval. This protocol will also be made available to EPA Region VI personnel, FLMs (Tim Allen of Fish and Wildlife Service and Judy Logan of Forest Service), and Arkansas Department of Environmental Quality personnel for their review.

A. Modeling Results Submittal

Sid Richardson will submit a final modeling report detailing the modeling procedures and results for the source-specific BART refined modeling analysis. Sid Richardson will also provide an electronic archive that includes the full set of CALPUFF inputs and model output fields.

B. Contact Information

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ATTACHMENT A.2

CALMET Control File Inputs

Parameter	Description	Default	CALMET Inputs
NUSTA	Number of upper air stations	N.A.	5
NOWSTA	Number of over water met stations	N.A.	0
IBYR	Starting year	N.A.	2001 (2002 and 2003 also modeled)
IBMO	Starting month	N.A.	1
IBDY	Starting day	N.A.	1
IBHR	Starting hour	N.A.	1
IBTZ	Base time zone	N.A.	0
IRLG	Length of run	N.A.	8760 (2002 - 8760, 2003 - 8748)
IRTYPE	Run type (must = 1 to run CALPUFF)	1	1
LCALGRD	Compute CALGRID data fields	T	F
ITEST	Stop run after SETUP to do input QA	2	2
PMAP	Map Projection	UTM	LCC
RLATO	Latitude (dec. degrees) of projection origin	N.A.	40N
RLONO	Longitude (dec. degrees) of projection origin	N.A.	97W
XLAT1	Matching parallel(s) of latitude for projection	N.A.	33N
XLAT2	Matching parallel(s) of latitude for projection	N.A.	45N
DATUM		WGS-G	WGS-G
NX	Number of X grid cells in meteorological grid	N.A.	306
NY	Number of Y grid cells in meteorological grid	N.A.	246
DGRIDKM	Grid spacing, km	N.A.	6
XORIGKM	Ref. Coordinate of SW corner of grid cell (1,1)	N.A.	-1008
YORIGKM	Ref. Coordinate of SW corner of grid cell (1,1)	N.A.	-1620
NZ	No. of vertical layers	N.A.	10
ZFACE	Cell face heights in arbitrary vertical grid, m	N.A.	0,20,40,80,160,320,640,1200,2000,3000,4000
LSAVE	Disk output option	T	T
IFORMO	Type of unformatted output file	1	1
LPRINT	Print met fields	F	F
IPRINF	Print intervals	1	1
IUVOUT(NZ)	Specify layers of u,v wind components to print	NZ*0	NZ*0
IWOUT(NZ)	Specify layers of w wind component to print	NZ*0	NZ*0
ITOUT(NZ)	Specify levels of 3-D temperature field to print	NZ*0	NZ*0
LDB	Print input met data and variables.	F	F
NN1	First time step for debug data and variables	1	1
NN2	Last time step for debug data to be printed	1	1
IOUTD	Control variable for writing test/debug wind fields	0	0
NZPRN2	Number of levels starting at surface to print	1	0
IPR0	Print interpolated wind components	0	0
IPR1	Print terrain adjusted surface wind components	0	0
IPR2	Print initial divergence fields	0	0
IPR3	Print final wind speed and direction	0	0
IPR4	Print final divergence fields	0	0
IPR5	Print winds after kinematic effects	0	0
IPR6	Print winds after Froude number adjustment	0	0
IPR7	Print winds after slope flows are added	0	0
IPR8	Print final wind field components	0	0
NOOBS	0=surface, overwater, or upper air observations	0	0
NSSTA	Number of meteorological surface stations	N.A.	347 (2002 - 351, 2003 - 375)
NPSTA	Number of precipitation stations	N.A.	347 (2002 - 351, 2003 - 375)
ICLOUD	Gridded cloud fields	0	0

Parameter	Description	Default	CALMET Inputs
IFORMS	Formatted surface meteorological data file	2	2
IFORMP	Formatted surface precipitation data file	2	2
IFORMC	Formatted cloud data file	2	2
IWFCOD	Model selection variable	1	1
IFRADJ	Compute Froude number adjustment effects?	1	1
IKINE	Compute kinematic effects?	0	0
IOBR	Use O'Brien (1970) vertical velocity adjustment?	0	0
ISLSOPE	Compute slope flow effects?	1	1
IEXTRP	Extrapolate surface wind obs to upper levels?	-4	-4
ICALM	Extrapolate surface winds even if calm?	0	0
BIAS	Layer-dependent biases weighting aloft measurements	NZ*0	0,0,0,0,0,0,0,0,0,0
RMIN2	Minimum vertical extrapolation distance	4	4
IPROG	14=Yes, use winds from MM5.DAT file as initial guess field [IWFCOD=1	0	14
ISTEPPG	MM5 output timestep	1	1
LVARY	Use varying radius of influence	F	F
RMAX1	Maximum radius of influence over land in sfc layer	N.A.	30
RMAX2	Maximum radius of influence over land aloft	N.A.	60
RMAX3	Maximum radius of influence over water	N.A.	60
RMIN	Minimum radius of influence used anywhere	0.1	0.1
TERRAD	Terrain features radius of influence	N.A.	10
R1	Weighting of first guess surface field	N.A.	6 (2002 and 2003 - 18)
R2	Weighting of first guess aloft field	N.A.	12 (2002 and 2003 - 36)
RPROG	MM5 windfield weighting parameter	N.A.	0
DIVLIM	Minimum divergence criterion	5 E -6	5 E -6
NITER	Number of divergence minimization iterations	50	50
NSMMTH	Number of passes through smoothing filter in each layer of CALMET	2,4,4,4,4,4,4	2,4,4,4,4,4,4
NITR2	Maximum number of stations used in each layer for the interpolation of data to a grid point	99	99
CRITFN	Critical Froude number	1	1
ALPHA	Kinematic effects parameter	0.1	0.1
FEXTR2	Scaling factor for extrapolating sfc winds aloft	NZ*0.0	NZ*0.0
NBAR	Number of terrain barriers	0	0
IDIOTP1	Surface temperature computation switch	0	0
ISURFT	Number of sfc met stations to use for temp. calcs.	N.A.	1
IDIOTP2	Domain-averaged lapse rate switch	0	0
IUPT	Upper air stations to use for lapse rate calculation	0	1
ZUPT	Depth through which lapse rate is calculated	200	200
IDIOPT3	Domain-averaged wind component switch	0	0
IUPWND	Number of aloft stations to use for wind calc.	-1	-1
ZUPWND(1)	Bottom and top of layer through which the domain-scale winds are computed	1	1
ZUPWND(2)		1000	1000
IDIOPT4	Observed surface wind component switch	0	0
IDIOPT5	Observed aloft wind component switch	0	0
LLBREZE	Use Lake Breeze Module	F	F
NBOX	Number of lake breeze regions	0	0
NLB	Number of stations in the region	N.A.	0
METBXID(NLB)	Station ID's in the region	N.A.	0
CONSTB	Neutral stability mixing height coefficient	1.41	1.41
CONSTE	Convective stability mixing height coefficient	0.15	0.15

Parameter	Description	Default	CALMET Inputs
CONSTN	Stable stability mixing height coefficient	2400	2400
CONSTW	Overwater mixing height coefficient	0.16	0.16
FCORIOL	Absolute value of Coriolis parameter	1 E -4	1 E -4
IAVEZI	Conduct spatial averaging? Yes = 1	1	1
MNMDAV	Maximum search radius in averaging process	1	10
HAFANG	Half-angle of upwind looking cone for averaging	30	30
ILEVZI	Layers of wind use in upwind averaging	1	1
DPTMIN	Minimum potential temperature lapse rate in the stable layer above the current convective mixing height	0.001	0.001
DZZI	Depth of layer above current conv., mixing height through which lapse rate is computed	200	200
ZIMIN	Minimum overland mixing height	50	50
ZIMAX	Maximum overland mixing height	3000	3000
ZIMINW	Minimum overwater mixing height	50	50
ZIMAXW	Maximum overwater mixing height	3000	3000
ITPROG	3D temperature from observations or from MM5?	0	0
IRAD	Type of interpolation; 1= 1/R	1	1
TRADKM	Temperature interpolation radius of influence	500	500
NUMTS	Max. number of stations for temp interpolation	5	5
IAVET	Spatially average temperatures? 1= yes	1	0
TGDEFB	Temp gradient below mixing height over water	-0.0098	-0.0098
TGDEFA	Temp gradient above mixing height over water	-0.0045	-0.0045
JWAT1	Beginning land use categories over water	N.A.	55
JWAT2	Ending land use categories for water	N.A.	55
NFLAGP	Precipitation interpolation flag; 2 = 1/R squared	2	2
SIGMAP	Radius of influence for precipitation interpolation	100	100
CUTP	Minimum precipitation rate cutoff (mm/hr)	0.01	0.01

ATTACHMENT A.3

Surface and Precipitation Stations

CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K4BL	3	-1088.794	-188.74
K4CR	4	-796.753	-614.946
K4MY	5	-820.552	-514.181
K6R6	6	-504.682	-1089.929
KAAO	7	-19.239	-248.771
KABI	8	-252.073	-836.385
KABQ	9	-870.967	-501.552
KACT	10	-20.572	-929.193
KADH	11	30.04	-574.23
KADS	12	15.55	-778.91
KAEG	13	-886.431	-489.863
KAEX	14	424.008	-951.083
KAFW	15	-29.84	-864.178
KAIZ	16	387.096	-200.609
KALI	17	-103.042	-1363.706
KALM	18	-839.633	-752.147
KALN	19	597.6	-100.613
KALS	20	-777.382	-244.023
KAMA	21	-425.225	-516.367
KARA	22	495.794	-1092.463
KARG	23	543.544	-409.481
KASD	24	691.97	-1044.068
KASG	25	257.655	-419.895
KATS	26	-699.341	-756.355
KATT	27	-67.189	-1077.024
KAUS	28	-64.44	-1085.31
KBAZ	29	-102.133	-1140.919
KBFM	30	857.496	-996.792
KBGD	31	-395.603	-466.083
KBLV	32	617.659	-136.018
KBMG	33	888.591	-45.013
KBMQ	34	-118.107	-1027.37
KBNA	35	920.716	-377.2
KBPK	36	404.476	-391.372
KBPT	37	289.282	-1110.638
KBRO	38	-44.198	-1571.387
KBTR	39	562.77	-1032.028
KBVE	40	741.254	-1153.502
KBVO	41	88.664	-358.933
KBVX	42	480.71	-457.819
KCAO	43	-547.124	-374.102
KCDS	44	-300.324	-610.634
KCEZ	45	-1020.893	-233.136
KCFV	46	126.511	-320.682
KCGI	47	652.519	-279.306

CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KCLL	48	60.926	-1044.347
KCNK	49	-55.418	-49.561
KCNM	50	-682.759	-822.078
KCNU	51	132.781	-256.9
KCNY	52	-1095.593	-59.385
KCOS	53	-663.999	-102.631
KCOT	54	-219.067	-1280.964
KCOU	55	411.894	-119.997
KCPS	56	591.654	-136.172
KCQC	57	-775.182	-516.728
KCRP	58	-49.841	-1360.392
KCRS	59	56.76	-882.852
KCSM	60	-198.798	-512.028
KCVN	61	-556.268	-599.276
KCVS	62	-577.834	-601.516
KCXO	63	153.025	-1068.554
KDAL	64	14.014	-791.889
KDCU	65	915.854	-541.281
KDDC	66	-259.327	-242.715
KDFW	67	-3.109	-786.339
KDHT	68	-496.517	-424.942
KDLF	69	-369.535	-1173.036
KDMN	70	-1006.923	-798.125
KDMO	71	336.438	-136.522
KDRO	72	-945.713	-259.162
KDRT	73	-382.557	-1172.484
KDTN	74	304.839	-822.047
KDTO	75	-18.599	-752.969
KDWH	76	140.407	-1100.838
KDYR	77	679.855	-412.145
KEAX	78	235.703	-128.032
KEFD	79	178.542	-1150.911
KEHA	80	-431.288	-320.167
KEHR	81	812.8	-199.338
KELP	82	-888.697	-862.785
KEMP	83	69.39	-183.984
KEND	84	-81.725	-403.278
KEVV	85	822.902	-172.718
KEWK	86	-24.383	-215.58
KF39	87	30.792	-697.387
KFAM	88	573.877	-225.83
KFDR	89	-181.762	-623.071
KFLP	90	404.266	-399.14
KFMN	91	-993.475	-297.941
KFOE	92	114.644	-115.26
KFSM	93	237.996	-512.835
KFST	94	-566.391	-988.873
KFTW	95	-32.713	-795.542

CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFWD	96	-27.846	-793.612
KFYV	97	253.764	-438.483
KGAG	98	-246.79	-405.469
KGBD	99	-162.152	-180.775
KGCK	100	-324.1	-221.895
KGDP	101	-737.521	-873.407
KGGG	102	214.599	-841.127
KGKY	103	-8.972	-812.595
KGLD	104	-401.583	-59.64
KGLH	105	557.042	-703.065
KGLS	106	208.675	-1189.492
KGNT	107	-985.121	-475.597
KGOK	108	-37.305	-458.997
KGPM	109	-4.681	-808.583
KGPT	110	764.04	-1031.678
KGTR	111	779.037	-689.11
KGTU	112	-65.338	-1033.51
KGUC	113	-855.846	-113.585
KGUP	114	-1060.45	-427.996
KGUY	115	-399.88	-356.694
KGWO	116	640.075	-695.287
KHBG	117	737.58	-936.506
KHBR	118	-186.121	-551.122
KHDO	119	-211.719	-1180.077
KHEZ	120	545.517	-911.954
KHGX	121	187.376	-1166.957
KHKA	122	642.067	-423.71
KHKS	123	636.926	-825.191
KHLC	124	-242.098	-64.417
KHNB	125	870.668	-145.447
KHOP	126	841.754	-324.602
KHOT	127	356.463	-602.864
KHOU	128	167.118	-1147.403
KHRL	129	-67.728	-1533.473
KHRO	130	343.012	-405.722
KHUM	131	616.723	-1136.814
KHUT	132	-75.456	-213.411
KHYI	133	-84.429	-1120.581
KHYS	134	-195.165	-124.724
KIAB	135	-23.366	-263.504
KIAH	136	159.982	-1112.067
KICT	137	-36.491	-259.771
KIER	138	369.594	-908.657
KILE	139	-65.316	-988.473
KINK	140	-586.879	-890.621
KITR	141	-451.837	-69.8
KIXD	142	180.857	-126.914
KJAN	143	650.08	-826.487

CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KJBR	144	569.655	-440.988
KJCT	145	-264.805	-1049.863
KJEF	146	417.469	-143.696
KJLN	147	220.368	-310.284
KLAA	148	-494.483	-198.304
KLAW	149	-129.378	-600.254
KLBB	150	-445.079	-691.2
KLBL	151	-350.15	-318.583
KLBX	152	150.63	-1207.65
KLCH	153	366.039	-1089.113
KLFK	154	214.642	-969.288
KLFT	155	483.139	-1074.12
KLHX	156	-567.01	-195.279
KLIC	157	-573.7	-69.147
KLIT	158	434.161	-571.401
KLIX	159	691.695	-1044.752
KLLQ	160	485.203	-691.199
KLRD	161	-246.569	-1383.486
KLRF	162	440.656	-550.693
KLRU	163	-917.261	-803.759
KLSX	164	544.697	-124.925
KLVJ	165	172.567	-1160.745
KLVS	166	-731.441	-447.785
KLWC	167	153.636	-108.143
KLWV	168	809.107	-95.154
KMAF	169	-489.696	-878.105
KMCB	170	622.67	-955.341
KMCI	171	195.298	-73.101
KMDH	172	676.591	-216.245
KMEG	173	651.863	-512.89
KMEI	174	774.908	-814.191
KMEM	175	634.534	-523.229
KMFE	176	-125.361	-1538.535
KMHK	177	28.579	-93.934
KMKC	178	205.861	-94.951
KMKL	179	727.077	-454.381
KMKO	180	146.966	-478.029
KMLC	181	110.644	-565.417
KMOB	182	839.42	-992.943
KMRF	183	-676.239	-1042.652
KMSL	184	853.332	-536.843
KMSY	185	653.767	-1087.37
KMTJ	186	-939.546	-109.53
KMVN	187	704.695	-154.57
KMWA	188	698.685	-218.021
KMWL	189	-99.741	-798.734
KNEW	190	674.286	-1080.207
KNGP	191	-28.264	-1368

CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KNQA	192	643.986	-489.146
KOCH	193	216.534	-930.592
KODO	194	-509.4	-880.305
KOJC	195	180.815	-125.068
KOKC	196	-54.186	-508.715
KOUN	197	-41.707	-526.861
KOWB	198	858.23	-202.317
KP28	199	-139.317	-297.355
KP92	200	557.13	-1172.603
KPAH	201	725.844	-291.476
KPBF	202	464.795	-631.204
KPIB	203	728.391	-915.201
KPIL	204	-33.55	-1540.831
KPNC	205	-8.868	-361.264
KPOF	206	591.592	-335.455
KPPF	207	130.459	-293.82
KPQL	208	814.856	-1019.221
KPRX	209	143.317	-703.629
KPSX	210	73.879	-1253.364
KPTN	211	551.151	-1123.941
KPUB	212	-651.703	-162.851
KPWA	213	-57.09	-493.927
KPWG	214	-30.433	-944.406
KRBD	215	12.481	-810.433
KRKP	216	-4.965	-1324.879
KRND	217	-125.115	-1161.171
KROG	218	258.441	-397.719
KROW	219	-698.85	-712.895
KRQE	220	-1083.18	-409.162
KRSL	221	-156.389	-123.748
KRSN	222	413.677	-819.685
KRTN	223	-664.239	-331.996
KRUE	224	352.817	-517.944
KRVS	225	90.474	-437.23
KSAF	226	-816.558	-444.045
KSAT	227	-142.994	-1160.901
KSET	228	564.392	-97.842
KSGF	229	318.465	-299.61
KSGR	230	131.473	-1151.365
KSGT	231	495.691	-582.749
KSHV	232	298.831	-829.307
KSJT	233	-333.267	-950.677
KSKX	234	-812.696	-797.619
KSLG	235	224.802	-417.183
KSLN	236	-56.011	-132.485
KSPD	237	-493.802	-285.159
KSPS	238	-136.546	-666.72
KSRC	239	475.987	-516.167

CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KSRR	240	-789.624	-686.256
KSSF	241	-144.978	-1183.291
KSTL	242	570.065	-117.452
KSUS	243	549.336	-130.02
KSVC	244	-1043.578	-751.807
KSWO	245	-7.445	-423.979
KSZL	246	297.567	-136.247
KTAD	247	-645.048	-278.061
KTBN	248	423.924	-237.479
KTCC	249	-597.363	-511.501
KTCL	250	870.684	-704.299
KTCS	251	-952.322	-695.439
KTIK	252	-34.608	-506.971
KTKI	253	38.139	-755.127
KTOP	254	117.322	-102.315
KTPL	255	-39.799	-981.183
KTRL	256	68.48	-806.796
KTUL	257	98.267	-419.701
KTUP	258	753.906	-600.367
KTVR	259	560.687	-829.118
KTXK	260	278.022	-720.622
KTYR	261	150.418	-844.347
KUNO	262	450.268	-332.422
KUTS	263	136.314	-1024.869
KVBT	264	247.807	-399.9
KVCT	265	8.192	-1238.695
KVIH	266	454.952	-193.303
KWDG	267	-71.289	-399.691
KWLD	268	0	-320.695
KXNA	269	240.016	-407.886
MMCL	270	-1072.535	-1632.775
KCWF	271	371.999	-1077.296
KHOB	272	-580.048	-790.648
KPOE	273	364.89	-984.772
MMIO	274	-715.54	-1595.056
MMMY	275	-316.613	-1579.702
KGRK	276	-79.671	-990.206
KMLU	277	466.016	-816.792
KTEX	278	-948.259	-169.74
MMRX	279	-125.617	-1557.41
KESF	280	447.345	-943.674
KLZK	281	431.199	-560.297
KADM	282	-1.531	-630.847
MMNL	283	-257.222	-1394.843
KE33	284	-846.39	-298.154
MMAN	285	-329.872	-1569.4
MMCS	286	-893.759	-880.938
MMMA	287	-54.487	-1586.451

CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KMWT	288	312.521	-597.597
K4SL	289	-889.332	-391.854
KSKF	290	-154.653	-1177.521
KBIX	291	778.283	-1028.545
KCBM	292	789.252	-665.842
KDYS	293	-267.671	-834.062
KAFF	294	-671.158	-85.372
KLTS	295	-206.759	-589.446
KNBG	296	677.608	-1102.405
KBYH	297	631.187	-421.631
KHMN	298	-848.745	-749.371
KLAM	299	-831.464	-412.856
KNMM	300	789.841	-788.597
MMPG	301	-346.402	-1248.84
MMTC	302	-660.346	-1590.033
KFSI	303	-127.711	-591.042
KFCS	304	-669.55	-116.96
KNFW	305	-40.525	-801.069
KNQI	306	-81.68	-1390.219
KBAD	307	312.771	-825.1
KFRI	308	20.033	-105.018
KGVT	309	86.944	-767.36
KHLR	310	-68.45	-981.004
KELD	311	390.361	-742.112
MMCU	312	-882.35	-1211.961
MMMV	313	-444.934	-1449.379
KEPZ	314	-915.897	-851.724
KAVK	315	-148.023	-355.847
KGMJ	316	200.75	-372.417
KPVJ	317	-20.054	-585.348
KRKR	318	216.017	-548.175
KCKV	319	849.69	-329.329
KOLV	320	654.146	-529.476
KDEQ	321	239.058	-655.169
KSLO	322	692.8	-118.63
KWWR	323	-225.565	-391.327
KAQR	324	77.8	-619.389
KCHK	325	-87.955	-541.668
KCQB	326	16.186	-473.43
KDUA	327	56.176	-670.61
KDUC	328	-87.786	-611.524
KENL	329	683.539	-134.985
KFOA	330	735.051	-91.448
KFWC	331	743.489	-143.961
KGCM	332	135.617	-409.198
KGLE	333	-18.489	-702.977
KHSB	334	737.259	-207.858
KJSV	335	198.556	-502.06

CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KJWG	336	-127.44	-456.946
KOKM	337	94.479	-478.439
KOLY	338	759.691	-104.636
KSAR	339	634.139	-179.076
KSNL	340	5.421	-513.325
KTQH	341	179.315	-448.216
K1H2	342	726.033	-68.974
KCPW	343	-858.907	-235.621
KMYP	344	-805.328	-126.737
KVTP	345	-715.975	-244.241
KHDC	346	632.988	-1028.708
KMNH	347	-652.817	-58.825

CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K4BL	3	-1088.794	-188.74
K4CR	4	-796.753	-614.946
K4MY	5	-820.552	-514.181
K4SL	6	-902.016	-397.882
K6R6	7	-504.682	-1089.929
KAAO	8	-19.239	-248.771
KABI	9	-252.073	-836.385
KABQ	10	-870.967	-501.552
KACT	11	-20.572	-929.193
KADH	12	30.04	-574.23
KADM	13	-1.531	-630.847
KADS	14	15.55	-778.91
KAEG	15	-886.431	-489.863
KAEX	16	424.008	-951.083
KAFW	17	-29.67	-778.139
KAIZ	18	387.096	-200.609
KALI	19	-102.174	-1362.836
KALM	20	-839.633	-752.147
KALN	21	597.6	-100.613
KALS	22	-777.382	-244.023
KAMA	23	-425.225	-516.367
KAQR	24	77.8	-619.389
KARA	25	495.794	-1092.463
KARG	26	543.544	-409.481
KASD	27	691.97	-1044.068
KASG	28	257.655	-419.895
KATS	29	-699.341	-756.355
KATT	30	-67.189	-1077.024
KAUS	31	-64.44	-1085.31
KAVK	32	-148.023	-355.847
KBAZ	33	-102.133	-1140.919
KBFM	34	857.496	-996.792
KBGD	35	-395.603	-466.083
KBMG	36	888.591	-45.013
KBMQ	37	-118.107	-1027.37
KBNA	38	920.716	-377.2
KBPK	39	404.476	-391.372
KBPT	40	289.282	-1110.638
KBRO	41	-44.198	-1571.387
KBTR	42	562.77	-1032.028
KBVE	43	741.254	-1153.502
KBVO	44	88.664	-358.933
KBVX	45	480.71	-457.819
KCAO	46	-547.124	-374.102
KCDS	47	-300.324	-610.634

CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KCEZ	48	-1020.893	-233.136
KCFV	49	126.511	-320.682
KCGI	50	652.519	-279.306
KCHK	51	-87.955	-541.668
KCKV	52	850.158	-329.28
KCLL	53	60.926	-1044.347
KCNK	54	-55.418	-49.561
KCNM	55	-681.361	-822.067
KCNU	56	132.781	-256.9
KCNY	57	-1095.593	-59.385
KCOS	58	-663.999	-102.631
KCOT	59	-219.079	-1280.593
KCOU	60	411.894	-119.997
KCPS	61	591.654	-136.172
KCQB	62	16.186	-473.43
KCQC	63	-775.182	-516.728
KCRP	64	-49.841	-1360.392
KCRS	65	56.76	-882.852
KCSM	66	-198.798	-512.028
KCVN	67	-556.268	-599.276
KCVS	68	-577.834	-601.516
KCXO	69	153.025	-1068.554
KDAL	70	14.014	-791.889
KDCU	71	915.854	-541.281
KDDC	72	-259.327	-242.715
KDEQ	73	238.943	-655.661
KDFW	74	-3.109	-786.339
KDHT	75	-496.517	-424.942
KDMN	76	-1006.923	-798.125
KDMO	77	336.438	-136.522
KDRO	78	-945.713	-259.162
KDRT	79	-382.557	-1172.484
KDTN	80	304.839	-822.047
KDTO	81	-18.599	-752.969
KDUA	82	56.176	-670.61
KDUC	83	-87.786	-611.524
KDWH	84	140.407	-1100.838
KDYR	85	679.855	-412.145
KEFD	86	178.542	-1150.911
KEHA	87	-431.288	-320.167
KEHR	88	812.8	-199.338
KELP	89	-888.697	-862.785
KEMP	90	69.39	-183.984
KENL	91	683.539	-134.985
KESF	92	447.345	-943.674
KEVV	93	822.902	-172.718
KEWK	94	-24.383	-215.58
KFAM	95	573.877	-225.83

CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFDR	96	-181.762	-623.071
KFLP	97	404.266	-399.14
KFMN	98	-993.475	-297.941
KFOA	99	735.051	-91.448
KFOE	100	114.644	-115.26
KFSM	101	237.996	-512.835
KFST	102	-566.391	-988.873
KFTW	103	-32.713	-795.542
KFWC	104	743.489	-143.961
KFWD	105	-27.846	-793.612
KFYV	106	253.764	-438.483
KGAG	107	-246.79	-405.469
KGBD	108	-162.152	-180.775
KGCK	109	-324.1	-221.895
KGCM	110	135.617	-409.198
KGDP	111	-737.521	-873.407
KGGG	112	214.599	-841.127
KGKY	113	-8.972	-812.595
KGLD	114	-401.583	-59.64
KGLE	115	-18.489	-702.977
KGLH	116	557.167	-701.877
KGLS	117	208.675	-1189.492
KGMJ	118	200.75	-372.417
KGNT	119	-985.121	-475.597
KGOK	120	-37.305	-458.997
KGPM	121	-4.681	-808.583
KGPT	122	764.04	-1031.678
KGRK	123	-79.671	-990.206
KGTR	124	779.037	-689.11
KGTU	125	-65.338	-1033.51
KGUC	126	-855.846	-113.585
KGUP	127	-1060.45	-427.996
KGUY	128	-399.88	-356.694
KGWO	129	640.075	-695.287
KHBG	130	737.58	-936.506
KHBR	131	-186.121	-551.122
KHDO	132	-211.719	-1180.077
KHEZ	133	545.517	-911.954
KHGX	134	187.376	-1166.957
KHKA	135	642.067	-423.71
KHKS	136	636.926	-825.191
KHLC	137	-242.098	-64.417
KHNB	138	870.668	-145.447
KHOB	139	-580.048	-790.648
KHOP	140	841.754	-324.602
KHOT	141	356.115	-603.71
KHOU	142	167.118	-1147.403
KHRL	143	-67.728	-1533.473

CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KHRO	144	343.012	-405.722
KHSB	145	737.259	-207.858
KHUM	146	616.723	-1136.814
KHUT	147	-75.456	-213.411
KHYI	148	-84.429	-1120.581
KHYS	149	-195.165	-124.724
KIAH	150	159.982	-1112.067
KICT	151	-36.491	-259.771
KIER	152	369.594	-908.657
KILE	153	-65.316	-988.473
KINK	154	-586.978	-890.95
KITR	155	-451.837	-69.8
KIXD	156	180.857	-126.914
KJAN	157	650.08	-826.487
KJBR	158	569.655	-440.988
KJCT	159	-264.805	-1049.863
KJEF	160	417.469	-143.696
KJLN	161	220.368	-310.284
KJSV	162	198.556	-502.06
KJWG	163	-127.44	-456.946
KLAA	164	-494.483	-198.304
KLAW	165	-129.378	-600.254
KLBB	166	-445.079	-691.2
KLBL	167	-350.15	-318.583
KLBX	168	150.63	-1207.65
KLCH	169	366.039	-1089.113
KLFK	170	214.642	-969.288
KLFT	171	483.139	-1074.12
KLHX	172	-567.01	-195.279
KLIC	173	-573.7	-69.147
KLIT	174	434.161	-571.401
KLLQ	175	485.203	-691.199
KLRD	176	-246.569	-1383.486
KLRU	177	-917.261	-803.759
KLSX	178	544.697	-124.925
KLVJ	179	172.567	-1160.745
KLVS	180	-731.441	-447.785
KLWC	181	153.636	-108.143
KLWV	182	809.107	-95.154
KMAF	183	-489.696	-878.105
KMCB	184	622.67	-955.341
KMCI	185	195.298	-73.101
KMDH	186	676.591	-216.245
KMEI	187	774.908	-814.191
KMEM	188	634.534	-523.229
KMFE	189	-125.361	-1538.535
KMHK	190	28.579	-93.934
KMKC	191	205.861	-94.951

CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KMKL	192	727.077	-454.381
KMKO	193	146.966	-478.029
KMLC	194	110.644	-565.417
KMLU	195	466.016	-816.792
KMOB	196	839.42	-992.943
KMRF	197	-676.239	-1042.652
KMSL	198	853.332	-536.843
KMSY	199	653.767	-1087.37
KMTJ	200	-939.546	-109.53
KMVN	201	704.695	-154.57
KMWA	202	698.685	-218.021
KMWL	203	-99.247	-798.862
KMWT	204	312.521	-597.597
KNEW	205	674.286	-1080.207
KNFW	206	-40.525	-801.069
KNGP	207	-28.264	-1368
KNQA	208	643.986	-489.146
KNQI	209	-81.68	-1390.219
KOCH	210	216.534	-930.592
KODO	211	-509.4	-880.305
KOJC	212	180.815	-125.068
KOKC	213	-54.186	-508.715
KOKM	214	94.479	-478.439
KOLV	215	654.146	-529.476
KOLY	216	759.691	-104.636
KOUN	217	-41.707	-526.861
KOWB	218	858.23	-202.317
KP28	219	-139.317	-297.355
KP92	220	557.13	-1172.603
KPAH	221	725.844	-291.476
KPBF	222	464.795	-631.204
KPIB	223	728.391	-915.201
KPIL	224	-33.55	-1540.831
KPNC	225	-9.037	-360.887
KPOF	226	591.592	-335.455
KPPF	227	130.459	-293.82
KPQL	228	814.856	-1019.221
KPRX	229	143.317	-703.629
KPSX	230	73.863	-1251.5
KPTN	231	551.151	-1123.941
KPUB	232	-651.703	-162.851
KPVJ	233	-20.054	-585.348
KPWA	234	-57.09	-493.927
KPWG	235	-30.433	-944.406
KRBD	236	12.481	-810.433
KRKP	237	-4.965	-1324.879
KRKR	238	216.017	-548.175
KROG	239	258.441	-397.719

CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KROW	240	-698.85	-712.895
KRQE	241	-1083.18	-409.162
KRSL	242	-156.389	-123.748
KRSN	243	413.677	-819.685
KRTN	244	-664.239	-331.996
KRUE	245	352.817	-517.944
KRVS	246	90.474	-437.23
KSAF	247	-816.558	-444.045
KSAR	248	634.139	-179.076
KSAT	249	-142.994	-1160.901
KSET	250	564.392	-97.842
KSGF	251	318.465	-299.61
KSGR	252	130.817	-1151.128
KSGT	253	495.691	-582.749
KSHV	254	298.831	-829.307
KSJT	255	-333.267	-950.677
KSKX	256	-770.438	-355.856
KSLG	257	224.802	-417.183
KSLN	258	-56.011	-132.485
KSLO	259	692.8	-118.63
KSNL	260	5.421	-513.325
KSPD	261	-493.802	-285.159
KSPS	262	-136.546	-666.72
KSRC	263	475.987	-516.167
KSRR	264	-789.624	-686.256
KSSF	265	-144.978	-1183.291
KSTL	266	570.065	-117.452
KSUS	267	549.336	-130.02
KSVC	268	-1043.578	-751.807
KSWO	269	-7.445	-423.979
KSZL	270	297.567	-136.247
KTAD	271	-644.899	-276.219
KTBN	272	423.924	-237.479
KTCC	273	-597.363	-511.501
KTCL	274	870.684	-704.299
KTCS	275	-952.322	-695.439
KTEX	276	-948.259	-169.74
KTIK	277	-34.608	-506.971
KTKI	278	38.139	-755.127
KTOP	279	117.322	-102.315
KTPL	280	-39.799	-981.183
KTQH	281	179.315	-448.216
KTRL	282	68.48	-806.796
KTUL	283	98.267	-419.701
KTUP	284	753.906	-600.367
KTVR	285	560.687	-829.118
KTXK	286	278.022	-720.622
KUNO	287	450.268	-332.422

CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KUTS	288	136.314	-1024.869
KVBT	289	247.807	-399.9
KVCT	290	8.192	-1238.695
KVIH	291	454.952	-193.303
KWLD	292	0	-320.695
KWWR	293	-225.565	-391.327
KXNA	294	240.016	-407.886
MMAN	295	-329.872	-1569.4
MMCL	296	-1072.535	-1632.775
MMMA	297	-54.487	-1586.451
MMMY	298	-316.613	-1579.702
MMNL	299	-257.222	-1394.843
MMPG	300	-346.402	-1248.84
MMRX	301	-125.617	-1557.41
KBLV	302	617.659	-136.018
KELD	303	389.07	-742.171
KF39	304	30.792	-697.387
KIAB	305	-23.366	-263.504
KSKF	306	-154.653	-1177.521
KTYR	307	150.418	-844.347
KWDG	308	-71.289	-399.691
KEAX	309	235.703	-128.032
KMEG	310	651.863	-512.89
KNBG	311	677.608	-1102.405
KLZK	312	431.199	-560.297
MMCS	313	-893.759	-880.938
KE33	314	-846.39	-298.154
KBIX	315	778.283	-1028.545
KLRF	316	440.656	-550.693
KFCS	317	-669.55	-116.96
KEND	318	-81.725	-403.278
KPOE	319	364.89	-984.772
KDYS	320	-267.671	-834.062
KHMN	321	-848.745	-749.371
KRND	322	-125.115	-1161.171
MMCU	323	-882.35	-1211.961
KBYH	324	631.187	-421.631
KFSI	325	-127.711	-591.042
KGVT	326	86.944	-767.36
KHLR	327	-68.45	-981.004
KNMM	328	789.841	-788.597
KLTS	329	-206.759	-589.446
KAFF	330	-671.158	-85.372
KCWF	331	371.999	-1077.296
KCBM	332	789.252	-665.842
KBAD	333	312.771	-825.1
KDLF	334	-369.535	-1173.036
MMTC	335	-660.346	-1590.033

CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
MMMV	336	-444.934	-1449.379
KFRI	337	20.033	-105.018
K1H2	338	726.033	-68.974
KCPW	339	-858.907	-235.621
KMYP	340	-805.328	-126.737
KVTP	341	-715.975	-244.241
KHDC	342	632.988	-1028.708
KMNH	343	-652.817	-58.825
K3T5	344	4.852	-1119.865
KLXT	345	226.086	-111.723
KFWS	346	-28.156	-830.79
KJAS	347	284.559	-1005.649
KLIX	348	691.695	-1044.752
KSWW	349	-325.719	-827.955
KERV	350	-201.944	-1109.346
KBWD	351	-184.672	-906.806

CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K1H2	3	726.033	-68.974
K3T5	4	4.852	-1119.865
K4BL	5	-1088.794	-188.74
K4CR	6	-796.753	-614.946
K4MY	7	-820.552	-514.181
K4SL	8	-902.016	-397.882
K6R6	9	-504.682	-1089.929
KAAO	10	-19.239	-248.771
KABI	11	-252.073	-836.385
KABQ	12	-870.967	-501.552
KACT	13	-20.572	-929.193
KADH	14	30.04	-574.23
KADM	15	-1.531	-630.847
KADS	16	15.55	-778.91
KAEG	17	-886.431	-489.863
KAEX	18	424.008	-951.083
KAFW	19	-29.67	-778.139
KAIZ	20	387.096	-200.609
KALI	21	-102.174	-1362.836
KALM	22	-839.633	-752.147
KALN	23	597.6	-100.613
KALS	24	-777.382	-244.023
KAMA	25	-425.225	-516.367
KAQR	26	77.8	-619.389
KARA	27	495.794	-1092.463
KARG	28	543.544	-409.481
KASD	29	691.97	-1044.068
KASG	30	257.655	-419.895
KATS	31	-699.341	-756.355
KATT	32	-67.189	-1077.024
KAUS	33	-64.44	-1085.31
KAVK	34	-148.023	-355.847
KBAZ	35	-102.133	-1140.919
KBFM	36	857.496	-996.792
KBGD	37	-395.603	-466.083
KBLV	38	617.659	-136.018
KBMG	39	888.591	-45.013
KBMQ	40	-118.107	-1027.37
KBNA	41	920.716	-377.2
KBPK	42	404.476	-391.372
KBPT	43	289.282	-1110.638
KBRO	44	-44.198	-1571.387
KBTR	45	562.77	-1032.028
KBVE	46	741.254	-1153.502
KBVO	47	88.664	-358.933

CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KBVX	48	480.71	-457.819
KBWD	49	-184.672	-906.806
KCAO	50	-547.124	-374.102
KCDS	51	-300.324	-610.634
KCEZ	52	-1020.893	-233.136
KCFV	53	126.511	-320.682
KCGI	54	652.519	-279.306
KCHK	55	-87.955	-541.668
KCKV	56	850.158	-329.28
KCLL	57	60.926	-1044.347
KCNK	58	-55.418	-49.561
KCNM	59	-681.361	-822.067
KCNU	60	132.781	-256.9
KCNY	61	-1095.593	-59.385
KCOS	62	-663.999	-102.631
KCOT	63	-219.079	-1280.593
KCOU	64	411.894	-119.997
KCPS	65	591.654	-136.172
KCPW	66	-858.907	-235.621
KCQB	67	16.186	-473.43
KCQC	68	-775.182	-516.728
KCRP	69	-49.841	-1360.392
KCRS	70	56.76	-882.852
KCSM	71	-198.798	-512.028
KCVN	72	-556.268	-599.276
KCVS	73	-577.834	-601.516
KCXO	74	153.025	-1068.554
KDCU	75	915.854	-541.281
KDDC	76	-259.327	-242.715
KDEQ	77	238.943	-655.661
KDFW	78	-3.109	-786.339
KDHT	79	-496.517	-424.942
KDMN	80	-1006.923	-798.125
KDMO	81	336.438	-136.522
KDRO	82	-945.713	-259.162
KDRT	83	-382.557	-1172.484
KDTN	84	304.839	-822.047
KDTO	85	-18.599	-752.969
KDUA	86	56.176	-670.61
KDUC	87	-87.786	-611.524
KDWH	88	140.407	-1100.838
KDYR	89	679.855	-412.145
KEFD	90	178.542	-1150.911
KEHA	91	-431.288	-320.167
KEHR	92	812.8	-199.338
KELD	93	389.07	-742.171
KELP	94	-888.697	-862.785
KEMP	95	69.39	-183.984

CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KENL	96	683.539	-134.985
KERV	97	-201.944	-1109.346
KESF	98	447.345	-943.674
KEVV	99	822.902	-172.718
KEWK	100	-24.383	-215.58
KF39	101	30.792	-697.387
KFAM	102	573.877	-225.83
KFDR	103	-181.762	-623.071
KFLP	104	404.266	-399.14
KFMN	105	-993.475	-297.941
KFOA	106	735.051	-91.448
KFOE	107	114.644	-115.26
KFSM	108	237.996	-512.835
KFST	109	-566.391	-988.873
KFTW	110	-32.713	-795.542
KFWC	111	743.489	-143.961
KFWS	112	-28.156	-830.79
KFYV	113	253.764	-438.483
KGAG	114	-246.79	-405.469
KGBD	115	-162.152	-180.775
KGCK	116	-324.1	-221.895
KGCM	117	135.617	-409.198
KGDP	118	-737.521	-873.407
KGGG	119	214.599	-841.127
KGKY	120	-8.972	-812.595
KGLD	121	-401.583	-59.64
KGLE	122	-18.489	-702.977
KGLH	123	557.167	-701.877
KGLS	124	208.675	-1189.492
KGMJ	125	200.75	-372.417
KGNT	126	-985.121	-475.597
KGOK	127	-37.305	-458.997
KGPM	128	-4.681	-808.583
KGPT	129	764.04	-1031.678
KGRK	130	-79.671	-990.206
KGTR	131	779.037	-689.11
KGTU	132	-65.338	-1033.51
KGUC	133	-855.846	-113.585
KGUP	134	-1060.45	-427.996
KGUY	135	-399.88	-356.694
KGWO	136	640.075	-695.287
KHBG	137	737.58	-936.506
KHBR	138	-186.121	-551.122
KHDC	139	632.988	-1028.708
KHDO	140	-211.719	-1180.077
KHEZ	141	545.517	-911.954
KHKA	142	642.067	-423.71
KHKS	143	636.926	-825.191

CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KHLC	144	-242.098	-64.417
KHNB	145	870.668	-145.447
KHOB	146	-580.048	-790.648
KHOP	147	841.754	-324.602
KHOT	148	356.115	-603.71
KHOU	149	167.118	-1147.403
KHRL	150	-67.728	-1533.473
KHRO	151	343.012	-405.722
KHSB	152	737.259	-207.858
KHUM	153	616.723	-1136.814
KHUT	154	-75.456	-213.411
KHYI	155	-84.429	-1120.581
KHYS	156	-195.165	-124.724
KIAB	157	-23.366	-263.504
KIAH	158	159.982	-1112.067
KICT	159	-36.491	-259.771
KIER	160	369.594	-908.657
KILE	161	-65.316	-988.473
KINK	162	-586.978	-890.95
KITR	163	-451.837	-69.8
KIXD	164	180.857	-126.914
KJAN	165	650.08	-826.487
KJAS	166	284.559	-1005.649
KJBR	167	569.655	-440.988
KJCT	168	-264.805	-1049.863
KJEF	169	417.469	-143.696
KJLN	170	220.368	-310.284
KJSV	171	198.556	-502.06
KJWG	172	-127.44	-456.946
KLAA	173	-494.483	-198.304
KLAW	174	-129.378	-600.254
KLBB	175	-445.079	-691.2
KLBL	176	-350.15	-318.583
KLBX	177	150.63	-1207.65
KLCH	178	366.039	-1089.113
KLFK	179	214.642	-969.288
KLFT	180	483.139	-1074.12
KLHX	181	-567.01	-195.279
KLIC	182	-573.7	-69.147
KLIT	183	434.161	-571.401
KLIX	184	691.695	-1044.752
KLLQ	185	485.203	-691.199
KLRD	186	-246.569	-1383.486
KLRU	187	-917.261	-803.759
KLVJ	188	172.567	-1160.745
KLVS	189	-731.441	-447.785
KLWC	190	153.636	-108.143
KLWV	191	809.107	-95.154

CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KLXT	192	226.086	-111.723
KLZK	193	431.199	-560.297
KMAF	194	-489.696	-878.105
KMCB	195	622.67	-955.341
KMCI	196	195.298	-73.101
KMDH	197	676.591	-216.245
KMEG	198	651.863	-512.89
KMEI	199	774.908	-814.191
KMEM	200	634.534	-523.229
KMFE	201	-125.361	-1538.535
KMHK	202	28.579	-93.934
KMKC	203	205.861	-94.951
KMKL	204	727.077	-454.381
KMKO	205	146.966	-478.029
KMLC	206	110.644	-565.417
KMLU	207	466.016	-816.792
KMNH	208	-652.817	-58.825
KMOB	209	839.42	-992.943
KMRF	210	-676.239	-1042.652
KMSL	211	853.332	-536.843
KMSY	212	653.767	-1087.37
KMTJ	213	-939.546	-109.53
KMVN	214	704.695	-154.57
KMWA	215	698.685	-218.021
KMWL	216	-99.247	-798.862
KMWT	217	312.521	-597.597
KMYP	218	-805.328	-126.737
KNEW	219	674.286	-1080.207
KNFW	220	-40.525	-801.069
KNGP	221	-28.264	-1368
KNQI	222	-81.68	-1390.219
KOCH	223	216.534	-930.592
KODO	224	-509.4	-880.305
KOJC	225	180.815	-125.068
KOKC	226	-54.186	-508.715
KOKM	227	94.479	-478.439
KOLV	228	654.146	-529.476
KOLY	229	759.691	-104.636
KOUN	230	-41.707	-526.861
KOWB	231	858.23	-202.317
KP28	232	-139.317	-297.355
KP92	233	557.13	-1172.603
KPAH	234	725.844	-291.476
KPBF	235	464.795	-631.204
KPIB	236	728.391	-915.201
KPIL	237	-33.55	-1540.831
KPNC	238	-9.037	-360.887
KPOF	239	591.592	-335.455

CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KPPF	240	130.459	-293.82
KPQL	241	814.856	-1019.221
KPRX	242	143.317	-703.629
KPSX	243	73.863	-1251.5
KPTN	244	551.151	-1123.941
KPUB	245	-651.703	-162.851
KPVJ	246	-20.054	-585.348
KPWA	247	-57.09	-493.927
KPWG	248	-30.433	-944.406
KRBD	249	12.481	-810.433
KRKP	250	-4.965	-1324.879
KRKR	251	216.017	-548.175
KROG	252	258.441	-397.719
KROW	253	-698.85	-712.895
KRQE	254	-1083.18	-409.162
KRSL	255	-156.389	-123.748
KRTN	256	-664.239	-331.996
KRUE	257	352.817	-517.944
KRVS	258	90.474	-437.23
KSAF	259	-816.558	-444.045
KSAR	260	634.139	-179.076
KSAT	261	-142.994	-1160.901
KSET	262	564.392	-97.842
KSGF	263	318.465	-299.61
KSGR	264	130.817	-1151.128
KSGT	265	495.691	-582.749
KSHV	266	298.831	-829.307
KSJT	267	-333.267	-950.677
KSKF	268	-154.653	-1177.521
KSKX	269	-770.438	-355.856
KSLG	270	224.802	-417.183
KSLN	271	-56.011	-132.485
KSLO	272	692.8	-118.63
KSNL	273	5.421	-513.325
KSPD	274	-493.802	-285.159
KSPS	275	-136.546	-666.72
KSRC	276	475.987	-516.167
KSRR	277	-789.624	-686.256
KSSF	278	-144.978	-1183.291
KSTL	279	570.065	-117.452
KSUS	280	549.336	-130.02
KSVC	281	-1043.578	-751.807
KSWO	282	-7.445	-423.979
KSWW	283	-325.719	-827.955
KTAD	284	-644.899	-276.219
KTBN	285	423.924	-237.479
KTCC	286	-597.363	-511.501
KTCL	287	870.684	-704.299

CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KTCS	288	-952.322	-695.439
KTEX	289	-948.259	-169.74
KTIK	290	-34.608	-506.971
KTKI	291	38.139	-755.127
KTOP	292	117.322	-102.315
KTPL	293	-39.799	-981.183
KTQH	294	179.315	-448.216
KTRL	295	68.48	-806.796
KTUL	296	98.267	-419.701
KTUP	297	753.906	-600.367
KTVR	298	560.687	-829.118
KTXK	299	278.022	-720.622
KTYR	300	150.418	-844.347
KUNO	301	450.268	-332.422
KUTS	302	136.314	-1024.869
KVBT	303	247.807	-399.9
KVCT	304	8.192	-1238.695
KVIH	305	454.952	-193.303
KVTP	306	-715.975	-244.241
KWDG	307	-71.289	-399.691
KWLD	308	0	-320.695
KWWR	309	-225.565	-391.327
KXNA	310	240.016	-407.886
MMRX	311	-125.617	-1557.41
KDAL	312	14.014	-791.889
KNQA	313	643.986	-489.146
MMCL	314	-1072.535	-1632.775
MMMA	315	-54.487	-1586.451
KCWF	316	371.999	-1077.296
KEAX	317	235.703	-128.032
KFWD	318	-27.846	-793.612
MMMY	319	-316.613	-1579.702
KSZL	320	297.567	-136.247
MMNL	321	-257.222	-1394.843
MMPG	322	-346.402	-1248.84
MMCS	323	-893.759	-880.938
KE33	324	-846.39	-298.154
MMAN	325	-329.872	-1569.4
MMTC	326	-660.346	-1590.033
KEND	327	-81.725	-403.278
KLRF	328	440.656	-550.693
KHMN	329	-848.745	-749.371
KAFF	330	-671.158	-85.372
KBIX	331	778.283	-1028.545
KFCS	332	-669.55	-116.96
KBAD	333	312.771	-825.1
KBYH	334	631.187	-421.631
KDYS	335	-267.671	-834.062

CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFSI	336	-127.711	-591.042
KHLR	337	-68.45	-981.004
KGVT	338	86.944	-767.36
KNMM	339	789.841	-788.597
KLTS	340	-206.759	-589.446
KRND	341	-125.115	-1161.171
MMCU	342	-882.35	-1211.961
KNBG	343	677.608	-1102.405
KCBM	344	789.252	-665.842
KPOE	345	364.89	-984.772
KDLF	346	-369.535	-1173.036
KRSN	347	413.677	-819.685
KLSX	348	544.697	-124.925
MMMV	349	-444.934	-1449.379
MMIO	350	-715.54	-1595.056
KSEP	351	-111.464	-861.645
K4T6	352	8.451	-835.284
K7F6	353	179.475	-707.745
KAWM	354	612.739	-515.624
KBKS	355	-112.415	-1422.608
KBPG	356	-425.646	-852.529
KBYY	357	111.937	-1224.526
KOSA	358	189.947	-761.973
KPYX	359	-333.955	-390.158
KT82	360	-184.545	-1081
KPVW	361	-432.871	-634.402
K25R	362	-114.5	-1509.609
K5T5	363	-9.437	-877.587
KE38	364	-643.74	-1043.615
KF05	365	-209.141	-635.991
KGYI	366	30.479	-695.167
KHHF	367	-304.913	-447.807
KHQZ	368	43.967	-802.91
KJSO	369	168.422	-899.337
KJWY	370	8.451	-835.284
KLBR	371	179.475	-707.745
KLUD	372	-53.902	-747.262
KSNK	373	-369.685	-801.662
KT53	374	-68.769	-1358.77
KRPH	375	-145.239	-761.747

CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K4BL	3	-1088.794	-188.74
K4CR	4	-796.753	-614.946
K4MY	5	-820.552	-514.181
K6R6	6	-504.682	-1089.929
KAAO	7	-19.239	-248.771
KABI	8	-252.073	-836.385
KABQ	9	-870.967	-501.552
KACT	10	-20.572	-929.193
KADH	11	30.04	-574.23
KADS	12	15.55	-778.91
KAEG	13	-886.431	-489.863
KAEX	14	424.008	-951.083
KAFW	15	-29.84	-864.178
KAIZ	16	387.096	-200.609
KALI	17	-103.042	-1363.706
KALM	18	-839.633	-752.147
KALN	19	597.6	-100.613
KALS	20	-777.382	-244.023
KAMA	21	-425.225	-516.367
KARA	22	495.794	-1092.463
KARG	23	543.544	-409.481
KASD	24	691.97	-1044.068
KASG	25	257.655	-419.895
KATS	26	-699.341	-756.355
KATT	27	-67.189	-1077.024
KAUS	28	-64.44	-1085.31
KBAZ	29	-102.133	-1140.919
KBFM	30	857.496	-996.792
KBGD	31	-395.603	-466.083
KBLV	32	617.659	-136.018
KBMG	33	888.591	-45.013
KBMQ	34	-118.107	-1027.37
KBNA	35	920.716	-377.2
KBPK	36	404.476	-391.372
KBPT	37	289.282	-1110.638
KBRO	38	-44.198	-1571.387
KBTR	39	562.77	-1032.028
KBVE	40	741.254	-1153.502
KBVO	41	88.664	-358.933
KBVX	42	480.71	-457.819
KCAO	43	-547.124	-374.102
KCDS	44	-300.324	-610.634
KCEZ	45	-1020.893	-233.136
KCFV	46	126.511	-320.682
KCGI	47	652.519	-279.306

CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KCLL	48	60.926	-1044.347
KCNK	49	-55.418	-49.561
KCNM	50	-682.759	-822.078
KCNU	51	132.781	-256.9
KCNY	52	-1095.593	-59.385
KCOS	53	-663.999	-102.631
KCOT	54	-219.067	-1280.964
KCOU	55	411.894	-119.997
KCPS	56	591.654	-136.172
KCQC	57	-775.182	-516.728
KCRP	58	-49.841	-1360.392
KCRS	59	56.76	-882.852
KCSM	60	-198.798	-512.028
KCVN	61	-556.268	-599.276
KCVS	62	-577.834	-601.516
KCXO	63	153.025	-1068.554
KDAL	64	14.014	-791.889
KDCU	65	915.854	-541.281
KDDC	66	-259.327	-242.715
KDFW	67	-3.109	-786.339
KDHT	68	-496.517	-424.942
KDLF	69	-369.535	-1173.036
KDMN	70	-1006.923	-798.125
KDMO	71	336.438	-136.522
KDRO	72	-945.713	-259.162
KDRT	73	-382.557	-1172.484
KDTN	74	304.839	-822.047
KDTO	75	-18.599	-752.969
KDWH	76	140.407	-1100.838
KDYR	77	679.855	-412.145
KEAX	78	235.703	-128.032
KEFD	79	178.542	-1150.911
KEHA	80	-431.288	-320.167
KEHR	81	812.8	-199.338
KELP	82	-888.697	-862.785
KEMP	83	69.39	-183.984
KEND	84	-81.725	-403.278
KEVV	85	822.902	-172.718
KEWK	86	-24.383	-215.58
KF39	87	30.792	-697.387
KFAM	88	573.877	-225.83
KFDR	89	-181.762	-623.071
KFLP	90	404.266	-399.14
KFMN	91	-993.475	-297.941
KFOE	92	114.644	-115.26
KFSM	93	237.996	-512.835
KFST	94	-566.391	-988.873
KFTW	95	-32.713	-795.542

CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFWD	96	-27.846	-793.612
KFYV	97	253.764	-438.483
KGAG	98	-246.79	-405.469
KGBD	99	-162.152	-180.775
KGCK	100	-324.1	-221.895
KGDP	101	-737.521	-873.407
KGGG	102	214.599	-841.127
KGKY	103	-8.972	-812.595
KGLD	104	-401.583	-59.64
KGLH	105	557.042	-703.065
KGLS	106	208.675	-1189.492
KGNT	107	-985.121	-475.597
KGOK	108	-37.305	-458.997
KGPM	109	-4.681	-808.583
KGPT	110	764.04	-1031.678
KGTR	111	779.037	-689.11
KGTU	112	-65.338	-1033.51
KGUC	113	-855.846	-113.585
KGUP	114	-1060.45	-427.996
KGUY	115	-399.88	-356.694
KGWO	116	640.075	-695.287
KHBG	117	737.58	-936.506
KHBR	118	-186.121	-551.122
KHDO	119	-211.719	-1180.077
KHEZ	120	545.517	-911.954
KHGX	121	187.376	-1166.957
KHKA	122	642.067	-423.71
KHKS	123	636.926	-825.191
KHLC	124	-242.098	-64.417
KHNB	125	870.668	-145.447
KHOP	126	841.754	-324.602
KHOT	127	356.463	-602.864
KHOU	128	167.118	-1147.403
KHRL	129	-67.728	-1533.473
KHRO	130	343.012	-405.722
KHUM	131	616.723	-1136.814
KHUT	132	-75.456	-213.411
KHYI	133	-84.429	-1120.581
KHYS	134	-195.165	-124.724
KIAB	135	-23.366	-263.504
KIAH	136	159.982	-1112.067
KICT	137	-36.491	-259.771
KIER	138	369.594	-908.657
KILE	139	-65.316	-988.473
KINK	140	-586.879	-890.621
KITR	141	-451.837	-69.8
KIXD	142	180.857	-126.914
KJAN	143	650.08	-826.487

CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KJBR	144	569.655	-440.988
KJCT	145	-264.805	-1049.863
KJEF	146	417.469	-143.696
KJLN	147	220.368	-310.284
KLAA	148	-494.483	-198.304
KLAW	149	-129.378	-600.254
KLBB	150	-445.079	-691.2
KLBL	151	-350.15	-318.583
KLBX	152	150.63	-1207.65
KLCH	153	366.039	-1089.113
KLFK	154	214.642	-969.288
KLFT	155	483.139	-1074.12
KLHX	156	-567.01	-195.279
KLIC	157	-573.7	-69.147
KLIT	158	434.161	-571.401
KLIX	159	691.695	-1044.752
KLLQ	160	485.203	-691.199
KLRD	161	-246.569	-1383.486
KLRF	162	440.656	-550.693
KLRU	163	-917.261	-803.759
KLSX	164	544.697	-124.925
KLVJ	165	172.567	-1160.745
KLVS	166	-731.441	-447.785
KLWC	167	153.636	-108.143
KLWV	168	809.107	-95.154
KMAF	169	-489.696	-878.105
KMCB	170	622.67	-955.341
KMCI	171	195.298	-73.101
KMDH	172	676.591	-216.245
KMEG	173	651.863	-512.89
KMEI	174	774.908	-814.191
KMEM	175	634.534	-523.229
KMFE	176	-125.361	-1538.535
KMHK	177	28.579	-93.934
KMKC	178	205.861	-94.951
KMKL	179	727.077	-454.381
KMKO	180	146.966	-478.029
KMLC	181	110.644	-565.417
KMOB	182	839.42	-992.943
KMRF	183	-676.239	-1042.652
KMSL	184	853.332	-536.843
KMSY	185	653.767	-1087.37
KMTJ	186	-939.546	-109.53
KMVN	187	704.695	-154.57
KMWA	188	698.685	-218.021
KMWL	189	-99.741	-798.734
KNEW	190	674.286	-1080.207
KNGP	191	-28.264	-1368

CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KNQA	192	643.986	-489.146
KOCH	193	216.534	-930.592
KODO	194	-509.4	-880.305
KOJC	195	180.815	-125.068
KOKC	196	-54.186	-508.715
KOUN	197	-41.707	-526.861
KOWB	198	858.23	-202.317
KP28	199	-139.317	-297.355
KP92	200	557.13	-1172.603
KPAH	201	725.844	-291.476
KPBF	202	464.795	-631.204
KPIB	203	728.391	-915.201
KPIL	204	-33.55	-1540.831
KPNC	205	-8.868	-361.264
KPOF	206	591.592	-335.455
KPPF	207	130.459	-293.82
KPQL	208	814.856	-1019.221
KPRX	209	143.317	-703.629
KPSX	210	73.879	-1253.364
KPTN	211	551.151	-1123.941
KPUB	212	-651.703	-162.851
KPWA	213	-57.09	-493.927
KPWG	214	-30.433	-944.406
KRBD	215	12.481	-810.433
KRKP	216	-4.965	-1324.879
KRND	217	-125.115	-1161.171
KROG	218	258.441	-397.719
KROW	219	-698.85	-712.895
KRQE	220	-1083.18	-409.162
KRSL	221	-156.389	-123.748
KRSN	222	413.677	-819.685
KRTN	223	-664.239	-331.996
KRUE	224	352.817	-517.944
KRVS	225	90.474	-437.23
KSAF	226	-816.558	-444.045
KSAT	227	-142.994	-1160.901
KSET	228	564.392	-97.842
KSGF	229	318.465	-299.61
KSGR	230	131.473	-1151.365
KSGT	231	495.691	-582.749
KSHV	232	298.831	-829.307
KSJT	233	-333.267	-950.677
KSKX	234	-812.696	-797.619
KSLG	235	224.802	-417.183
KSLN	236	-56.011	-132.485
KSPD	237	-493.802	-285.159
KSPS	238	-136.546	-666.72
KSRC	239	475.987	-516.167

CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KSRR	240	-789.624	-686.256
KSSF	241	-144.978	-1183.291
KSTL	242	570.065	-117.452
KSUS	243	549.336	-130.02
KSVC	244	-1043.578	-751.807
KSWO	245	-7.445	-423.979
KSZL	246	297.567	-136.247
KTAD	247	-645.048	-278.061
KTBN	248	423.924	-237.479
KTCC	249	-597.363	-511.501
KTCL	250	870.684	-704.299
KTCS	251	-952.322	-695.439
KTIK	252	-34.608	-506.971
KTKI	253	38.139	-755.127
KTOP	254	117.322	-102.315
KTPL	255	-39.799	-981.183
KTRL	256	68.48	-806.796
KTUL	257	98.267	-419.701
KTUP	258	753.906	-600.367
KTVR	259	560.687	-829.118
KTXK	260	278.022	-720.622
KTYR	261	150.418	-844.347
KUNO	262	450.268	-332.422
KUTS	263	136.314	-1024.869
KVBT	264	247.807	-399.9
KVCT	265	8.192	-1238.695
KVIH	266	454.952	-193.303
KWDG	267	-71.289	-399.691
KWLD	268	0	-320.695
KXNA	269	240.016	-407.886
MMCL	270	-1072.535	-1632.775
KCWF	271	371.999	-1077.296
KHOB	272	-580.048	-790.648
KPOE	273	364.89	-984.772
MMIO	274	-715.54	-1595.056
MMMY	275	-316.613	-1579.702
KGRK	276	-79.671	-990.206
KMLU	277	466.016	-816.792
KTEX	278	-948.259	-169.74
MMRX	279	-125.617	-1557.41
KESF	280	447.345	-943.674
KLZK	281	431.199	-560.297
KADM	282	-1.531	-630.847
MMNL	283	-257.222	-1394.843
KE33	284	-846.39	-298.154
MMAN	285	-329.872	-1569.4
MMCS	286	-893.759	-880.938
MMMA	287	-54.487	-1586.451

CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KMWT	288	312.521	-597.597
K4SL	289	-889.332	-391.854
KSKF	290	-154.653	-1177.521
KBIX	291	778.283	-1028.545
KCBM	292	789.252	-665.842
KDYS	293	-267.671	-834.062
KAFF	294	-671.158	-85.372
KLTS	295	-206.759	-589.446
KNBG	296	677.608	-1102.405
KBYH	297	631.187	-421.631
KHMN	298	-848.745	-749.371
KLAM	299	-831.464	-412.856
KNMM	300	789.841	-788.597
MMPG	301	-346.402	-1248.84
MMTC	302	-660.346	-1590.033
KFSI	303	-127.711	-591.042
KFCS	304	-669.55	-116.96
KNFW	305	-40.525	-801.069
KNQI	306	-81.68	-1390.219
KBAD	307	312.771	-825.1
KFRI	308	20.033	-105.018
KGVT	309	86.944	-767.36
KHLR	310	-68.45	-981.004
KELD	311	390.361	-742.112
MMCU	312	-882.35	-1211.961
MMMV	313	-444.934	-1449.379
KEPZ	314	-915.897	-851.724
KAVK	315	-148.023	-355.847
KGMJ	316	200.75	-372.417
KPVJ	317	-20.054	-585.348
KRKR	318	216.017	-548.175
KCKV	319	849.69	-329.329
KOLV	320	654.146	-529.476
KDEQ	321	239.058	-655.169
KSLO	322	692.8	-118.63
KWWR	323	-225.565	-391.327
KAQR	324	77.8	-619.389
KCHK	325	-87.955	-541.668
KCQB	326	16.186	-473.43
KDUA	327	56.176	-670.61
KDUC	328	-87.786	-611.524
KENL	329	683.539	-134.985
KFOA	330	735.051	-91.448
KFWC	331	743.489	-143.961
KGCM	332	135.617	-409.198
KGLE	333	-18.489	-702.977
KHSB	334	737.259	-207.858
KJSV	335	198.556	-502.06

CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KJWG	336	-127.44	-456.946
KOKM	337	94.479	-478.439
KOLY	338	759.691	-104.636
KSAR	339	634.139	-179.076
KSNL	340	5.421	-513.325
KTQH	341	179.315	-448.216
K1H2	342	726.033	-68.974
KCPW	343	-858.907	-235.621
KMYP	344	-805.328	-126.737
KVTP	345	-715.975	-244.241
KHDC	346	632.988	-1028.708
KMNH	347	-652.817	-58.825

CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K4BL	3	-1088.794	-188.74
K4CR	4	-796.753	-614.946
K4MY	5	-820.552	-514.181
K4SL	6	-902.016	-397.882
K6R6	7	-504.682	-1089.929
KAAO	8	-19.239	-248.771
KABI	9	-252.073	-836.385
KABQ	10	-870.967	-501.552
KACT	11	-20.572	-929.193
KADH	12	30.04	-574.23
KADM	13	-1.531	-630.847
KADS	14	15.55	-778.91
KAEG	15	-886.431	-489.863
KAEX	16	424.008	-951.083
KAFW	17	-29.67	-778.139
KAIZ	18	387.096	-200.609
KALI	19	-102.174	-1362.836
KALM	20	-839.633	-752.147
KALN	21	597.6	-100.613
KALS	22	-777.382	-244.023
KAMA	23	-425.225	-516.367
KAQR	24	77.8	-619.389
KARA	25	495.794	-1092.463
KARG	26	543.544	-409.481
KASD	27	691.97	-1044.068
KASG	28	257.655	-419.895
KATS	29	-699.341	-756.355
KATT	30	-67.189	-1077.024
KAUS	31	-64.44	-1085.31
KAVK	32	-148.023	-355.847
KBAZ	33	-102.133	-1140.919
KBFM	34	857.496	-996.792
KBGD	35	-395.603	-466.083
KBMG	36	888.591	-45.013
KBMQ	37	-118.107	-1027.37
KBNA	38	920.716	-377.2
KBPK	39	404.476	-391.372
KBPT	40	289.282	-1110.638
KBRO	41	-44.198	-1571.387
KBTR	42	562.77	-1032.028
KBVE	43	741.254	-1153.502
KBVO	44	88.664	-358.933
KBVX	45	480.71	-457.819
KCAO	46	-547.124	-374.102
KCDS	47	-300.324	-610.634

CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KCEZ	48	-1020.893	-233.136
KCFV	49	126.511	-320.682
KCGI	50	652.519	-279.306
KCHK	51	-87.955	-541.668
KCKV	52	850.158	-329.28
KCLL	53	60.926	-1044.347
KCNK	54	-55.418	-49.561
KCNM	55	-681.361	-822.067
KCNU	56	132.781	-256.9
KCNY	57	-1095.593	-59.385
KCOS	58	-663.999	-102.631
KCOT	59	-219.079	-1280.593
KCOU	60	411.894	-119.997
KCPS	61	591.654	-136.172
KCQB	62	16.186	-473.43
KCQC	63	-775.182	-516.728
KCRP	64	-49.841	-1360.392
KCRS	65	56.76	-882.852
KCSM	66	-198.798	-512.028
KCVN	67	-556.268	-599.276
KCVS	68	-577.834	-601.516
KCXO	69	153.025	-1068.554
KDAL	70	14.014	-791.889
KDCU	71	915.854	-541.281
KDDC	72	-259.327	-242.715
KDEQ	73	238.943	-655.661
KDFW	74	-3.109	-786.339
KDHT	75	-496.517	-424.942
KDMN	76	-1006.923	-798.125
KDMO	77	336.438	-136.522
KDRO	78	-945.713	-259.162
KDRT	79	-382.557	-1172.484
KDTN	80	304.839	-822.047
KDTO	81	-18.599	-752.969
KDUA	82	56.176	-670.61
KDUC	83	-87.786	-611.524
KDWH	84	140.407	-1100.838
KDYR	85	679.855	-412.145
KEFD	86	178.542	-1150.911
KEHA	87	-431.288	-320.167
KEHR	88	812.8	-199.338
KELP	89	-888.697	-862.785
KEMP	90	69.39	-183.984
KENL	91	683.539	-134.985
KESF	92	447.345	-943.674
KEVV	93	822.902	-172.718
KEWK	94	-24.383	-215.58
KFAM	95	573.877	-225.83

CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFDR	96	-181.762	-623.071
KFLP	97	404.266	-399.14
KFMN	98	-993.475	-297.941
KFOA	99	735.051	-91.448
KFOE	100	114.644	-115.26
KFSM	101	237.996	-512.835
KFST	102	-566.391	-988.873
KFTW	103	-32.713	-795.542
KFWC	104	743.489	-143.961
KFWD	105	-27.846	-793.612
KFYV	106	253.764	-438.483
KGAG	107	-246.79	-405.469
KGBD	108	-162.152	-180.775
KGCK	109	-324.1	-221.895
KGCM	110	135.617	-409.198
KGDP	111	-737.521	-873.407
KGGG	112	214.599	-841.127
KGKY	113	-8.972	-812.595
KGLD	114	-401.583	-59.64
KGLE	115	-18.489	-702.977
KGLH	116	557.167	-701.877
KGLS	117	208.675	-1189.492
KGMJ	118	200.75	-372.417
KGNT	119	-985.121	-475.597
KGOK	120	-37.305	-458.997
KGPM	121	-4.681	-808.583
KGPT	122	764.04	-1031.678
KGRK	123	-79.671	-990.206
KGTR	124	779.037	-689.11
KGTU	125	-65.338	-1033.51
KGUC	126	-855.846	-113.585
KGUP	127	-1060.45	-427.996
KGUY	128	-399.88	-356.694
KGWO	129	640.075	-695.287
KHBG	130	737.58	-936.506
KHBR	131	-186.121	-551.122
KHDO	132	-211.719	-1180.077
KHEZ	133	545.517	-911.954
KHGX	134	187.376	-1166.957
KHKA	135	642.067	-423.71
KHKS	136	636.926	-825.191
KHLC	137	-242.098	-64.417
KHNB	138	870.668	-145.447
KHOB	139	-580.048	-790.648
KHOP	140	841.754	-324.602
KHOT	141	356.115	-603.71
KHOU	142	167.118	-1147.403
KHRL	143	-67.728	-1533.473

CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KHRO	144	343.012	-405.722
KHSB	145	737.259	-207.858
KHUM	146	616.723	-1136.814
KHUT	147	-75.456	-213.411
KHYI	148	-84.429	-1120.581
KHYS	149	-195.165	-124.724
KIAH	150	159.982	-1112.067
KICT	151	-36.491	-259.771
KIER	152	369.594	-908.657
KILE	153	-65.316	-988.473
KINK	154	-586.978	-890.95
KITR	155	-451.837	-69.8
KIXD	156	180.857	-126.914
KJAN	157	650.08	-826.487
KJBR	158	569.655	-440.988
KJCT	159	-264.805	-1049.863
KJEF	160	417.469	-143.696
KJLN	161	220.368	-310.284
KJSV	162	198.556	-502.06
KJWG	163	-127.44	-456.946
KLAA	164	-494.483	-198.304
KLAW	165	-129.378	-600.254
KLBB	166	-445.079	-691.2
KLBL	167	-350.15	-318.583
KLBX	168	150.63	-1207.65
KLCH	169	366.039	-1089.113
KLFK	170	214.642	-969.288
KLFT	171	483.139	-1074.12
KLHX	172	-567.01	-195.279
KLIC	173	-573.7	-69.147
KLIT	174	434.161	-571.401
KLLQ	175	485.203	-691.199
KLRD	176	-246.569	-1383.486
KLRU	177	-917.261	-803.759
KLSX	178	544.697	-124.925
KLVJ	179	172.567	-1160.745
KLVS	180	-731.441	-447.785
KLWC	181	153.636	-108.143
KLWV	182	809.107	-95.154
KMAF	183	-489.696	-878.105
KMCB	184	622.67	-955.341
KMCI	185	195.298	-73.101
KMDH	186	676.591	-216.245
KMEI	187	774.908	-814.191
KMEM	188	634.534	-523.229
KMFE	189	-125.361	-1538.535
KMHK	190	28.579	-93.934
KMKC	191	205.861	-94.951

CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KMKL	192	727.077	-454.381
KMKO	193	146.966	-478.029
KMLC	194	110.644	-565.417
KMLU	195	466.016	-816.792
KMOB	196	839.42	-992.943
KMRF	197	-676.239	-1042.652
KMSL	198	853.332	-536.843
KMSY	199	653.767	-1087.37
KMTJ	200	-939.546	-109.53
KMVN	201	704.695	-154.57
KMWA	202	698.685	-218.021
KMWL	203	-99.247	-798.862
KMWT	204	312.521	-597.597
KNEW	205	674.286	-1080.207
KNFW	206	-40.525	-801.069
KNGP	207	-28.264	-1368
KNQA	208	643.986	-489.146
KNQI	209	-81.68	-1390.219
KOCH	210	216.534	-930.592
KODO	211	-509.4	-880.305
KOJC	212	180.815	-125.068
KOKC	213	-54.186	-508.715
KOKM	214	94.479	-478.439
KOLV	215	654.146	-529.476
KOLY	216	759.691	-104.636
KOUN	217	-41.707	-526.861
KOWB	218	858.23	-202.317
KP28	219	-139.317	-297.355
KP92	220	557.13	-1172.603
KPAH	221	725.844	-291.476
KPBF	222	464.795	-631.204
KPIB	223	728.391	-915.201
KPIL	224	-33.55	-1540.831
KPNC	225	-9.037	-360.887
KPOF	226	591.592	-335.455
KPPF	227	130.459	-293.82
KPQL	228	814.856	-1019.221
KPRX	229	143.317	-703.629
KPSX	230	73.863	-1251.5
KPTN	231	551.151	-1123.941
KPUB	232	-651.703	-162.851
KPVJ	233	-20.054	-585.348
KPWA	234	-57.09	-493.927
KPWG	235	-30.433	-944.406
KRBD	236	12.481	-810.433
KRKP	237	-4.965	-1324.879
KRKR	238	216.017	-548.175
KROG	239	258.441	-397.719

CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KROW	240	-698.85	-712.895
KRQE	241	-1083.18	-409.162
KRSL	242	-156.389	-123.748
KRSN	243	413.677	-819.685
KRTN	244	-664.239	-331.996
KRUE	245	352.817	-517.944
KRVS	246	90.474	-437.23
KSAF	247	-816.558	-444.045
KSAR	248	634.139	-179.076
KSAT	249	-142.994	-1160.901
KSET	250	564.392	-97.842
KSGF	251	318.465	-299.61
KSGR	252	130.817	-1151.128
KSGT	253	495.691	-582.749
KSHV	254	298.831	-829.307
KSJT	255	-333.267	-950.677
KSKX	256	-770.438	-355.856
KSLG	257	224.802	-417.183
KSLN	258	-56.011	-132.485
KSLO	259	692.8	-118.63
KSNL	260	5.421	-513.325
KSPD	261	-493.802	-285.159
KSPS	262	-136.546	-666.72
KSRC	263	475.987	-516.167
KSRR	264	-789.624	-686.256
KSSF	265	-144.978	-1183.291
KSTL	266	570.065	-117.452
KSUS	267	549.336	-130.02
KSVC	268	-1043.578	-751.807
KSWO	269	-7.445	-423.979
KSZL	270	297.567	-136.247
KTAD	271	-644.899	-276.219
KTBN	272	423.924	-237.479
KTCC	273	-597.363	-511.501
KTCL	274	870.684	-704.299
KTCS	275	-952.322	-695.439
KTEX	276	-948.259	-169.74
KTIK	277	-34.608	-506.971
KTKI	278	38.139	-755.127
KTOP	279	117.322	-102.315
KTPL	280	-39.799	-981.183
KTQH	281	179.315	-448.216
KTRL	282	68.48	-806.796
KTUL	283	98.267	-419.701
KTUP	284	753.906	-600.367
KTVR	285	560.687	-829.118
KTXK	286	278.022	-720.622
KUNO	287	450.268	-332.422

CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KUTS	288	136.314	-1024.869
KVBT	289	247.807	-399.9
KVCT	290	8.192	-1238.695
KVIH	291	454.952	-193.303
KWLD	292	0	-320.695
KWWR	293	-225.565	-391.327
KXNA	294	240.016	-407.886
MMAN	295	-329.872	-1569.4
MMCL	296	-1072.535	-1632.775
MMMA	297	-54.487	-1586.451
MMMY	298	-316.613	-1579.702
MMNL	299	-257.222	-1394.843
MMPG	300	-346.402	-1248.84
MMRX	301	-125.617	-1557.41
KBLV	302	617.659	-136.018
KELD	303	389.07	-742.171
KF39	304	30.792	-697.387
KIAB	305	-23.366	-263.504
KSKF	306	-154.653	-1177.521
KTYR	307	150.418	-844.347
KWDG	308	-71.289	-399.691
KEAX	309	235.703	-128.032
KMEG	310	651.863	-512.89
KNBG	311	677.608	-1102.405
KLZK	312	431.199	-560.297
MMCS	313	-893.759	-880.938
KE33	314	-846.39	-298.154
KBIX	315	778.283	-1028.545
KLRF	316	440.656	-550.693
KFCS	317	-669.55	-116.96
KEND	318	-81.725	-403.278
KPOE	319	364.89	-984.772
KDYS	320	-267.671	-834.062
KHMN	321	-848.745	-749.371
KRND	322	-125.115	-1161.171
MMCU	323	-882.35	-1211.961
KBYH	324	631.187	-421.631
KFSI	325	-127.711	-591.042
KGVT	326	86.944	-767.36
KHLR	327	-68.45	-981.004
KNMM	328	789.841	-788.597
KLTS	329	-206.759	-589.446
KAFF	330	-671.158	-85.372
KCWF	331	371.999	-1077.296
KCBM	332	789.252	-665.842
KBAD	333	312.771	-825.1
KDLF	334	-369.535	-1173.036
MMTC	335	-660.346	-1590.033

CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
MMMV	336	-444.934	-1449.379
KFRI	337	20.033	-105.018
K1H2	338	726.033	-68.974
KCPW	339	-858.907	-235.621
KMYP	340	-805.328	-126.737
KVTP	341	-715.975	-244.241
KHDC	342	632.988	-1028.708
KMNH	343	-652.817	-58.825
K3T5	344	4.852	-1119.865
KLXT	345	226.086	-111.723
KFWS	346	-28.156	-830.79
KJAS	347	284.559	-1005.649
KLIX	348	691.695	-1044.752
KSWW	349	-325.719	-827.955
KERV	350	-201.944	-1109.346
KBWD	351	-184.672	-906.806

CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K1H2	3	726.033	-68.974
K3T5	4	4.852	-1119.865
K4BL	5	-1088.794	-188.74
K4CR	6	-796.753	-614.946
K4MY	7	-820.552	-514.181
K4SL	8	-902.016	-397.882
K6R6	9	-504.682	-1089.929
KAAO	10	-19.239	-248.771
KABI	11	-252.073	-836.385
KABQ	12	-870.967	-501.552
KACT	13	-20.572	-929.193
KADH	14	30.04	-574.23
KADM	15	-1.531	-630.847
KADS	16	15.55	-778.91
KAEG	17	-886.431	-489.863
KAEX	18	424.008	-951.083
KAFW	19	-29.67	-778.139
KAIZ	20	387.096	-200.609
KALI	21	-102.174	-1362.836
KALM	22	-839.633	-752.147
KALN	23	597.6	-100.613
KALS	24	-777.382	-244.023
KAMA	25	-425.225	-516.367
KAQR	26	77.8	-619.389
KARA	27	495.794	-1092.463
KARG	28	543.544	-409.481
KASD	29	691.97	-1044.068
KASG	30	257.655	-419.895
KATS	31	-699.341	-756.355
KATT	32	-67.189	-1077.024
KAUS	33	-64.44	-1085.31
KAVK	34	-148.023	-355.847
KBAZ	35	-102.133	-1140.919
KBFM	36	857.496	-996.792
KBGD	37	-395.603	-466.083
KBLV	38	617.659	-136.018
KBMG	39	888.591	-45.013
KBMQ	40	-118.107	-1027.37
KBNA	41	920.716	-377.2
KBPK	42	404.476	-391.372
KBPT	43	289.282	-1110.638
KBRO	44	-44.198	-1571.387
KBTR	45	562.77	-1032.028
KBVE	46	741.254	-1153.502
KBVO	47	88.664	-358.933

CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KBVX	48	480.71	-457.819
KBWD	49	-184.672	-906.806
KCAO	50	-547.124	-374.102
KCDS	51	-300.324	-610.634
KCEZ	52	-1020.893	-233.136
KCFV	53	126.511	-320.682
KCGI	54	652.519	-279.306
KCHK	55	-87.955	-541.668
KCKV	56	850.158	-329.28
KCLL	57	60.926	-1044.347
KCNK	58	-55.418	-49.561
KCNM	59	-681.361	-822.067
KCNU	60	132.781	-256.9
KCNY	61	-1095.593	-59.385
KCOS	62	-663.999	-102.631
KCOT	63	-219.079	-1280.593
KCOU	64	411.894	-119.997
KCPS	65	591.654	-136.172
KCPW	66	-858.907	-235.621
KCQB	67	16.186	-473.43
KCQC	68	-775.182	-516.728
KCRP	69	-49.841	-1360.392
KCRS	70	56.76	-882.852
KCSM	71	-198.798	-512.028
KCVN	72	-556.268	-599.276
KCVS	73	-577.834	-601.516
KCXO	74	153.025	-1068.554
KDCU	75	915.854	-541.281
KDDC	76	-259.327	-242.715
KDEQ	77	238.943	-655.661
KDFW	78	-3.109	-786.339
KDHT	79	-496.517	-424.942
KDMN	80	-1006.923	-798.125
KDMO	81	336.438	-136.522
KDRO	82	-945.713	-259.162
KDRT	83	-382.557	-1172.484
KDTN	84	304.839	-822.047
KDTO	85	-18.599	-752.969
KDUA	86	56.176	-670.61
KDUC	87	-87.786	-611.524
KDWH	88	140.407	-1100.838
KDYR	89	679.855	-412.145
KEFD	90	178.542	-1150.911
KEHA	91	-431.288	-320.167
KEHR	92	812.8	-199.338
KELD	93	389.07	-742.171
KELP	94	-888.697	-862.785
KEMP	95	69.39	-183.984

CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KENL	96	683.539	-134.985
KERV	97	-201.944	-1109.346
KESF	98	447.345	-943.674
KEVV	99	822.902	-172.718
KEWK	100	-24.383	-215.58
KF39	101	30.792	-697.387
KFAM	102	573.877	-225.83
KFDR	103	-181.762	-623.071
KFLP	104	404.266	-399.14
KFMN	105	-993.475	-297.941
KFOA	106	735.051	-91.448
KFOE	107	114.644	-115.26
KFSM	108	237.996	-512.835
KFST	109	-566.391	-988.873
KFTW	110	-32.713	-795.542
KFWC	111	743.489	-143.961
KFWS	112	-28.156	-830.79
KFYV	113	253.764	-438.483
KGAG	114	-246.79	-405.469
KGBD	115	-162.152	-180.775
KGCK	116	-324.1	-221.895
KGCM	117	135.617	-409.198
KGDP	118	-737.521	-873.407
KGGG	119	214.599	-841.127
KGKY	120	-8.972	-812.595
KGLD	121	-401.583	-59.64
KGLE	122	-18.489	-702.977
KGLH	123	557.167	-701.877
KGLS	124	208.675	-1189.492
KGMJ	125	200.75	-372.417
KGNT	126	-985.121	-475.597
KGOK	127	-37.305	-458.997
KGPM	128	-4.681	-808.583
KGPT	129	764.04	-1031.678
KGRK	130	-79.671	-990.206
KGTR	131	779.037	-689.11
KGTU	132	-65.338	-1033.51
KGUC	133	-855.846	-113.585
KGUP	134	-1060.45	-427.996
KGUY	135	-399.88	-356.694
KGWO	136	640.075	-695.287
KHBG	137	737.58	-936.506
KHBR	138	-186.121	-551.122
KHDC	139	632.988	-1028.708
KHDO	140	-211.719	-1180.077
KHEZ	141	545.517	-911.954
KHKA	142	642.067	-423.71
KHKS	143	636.926	-825.191

CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KHLC	144	-242.098	-64.417
KHNB	145	870.668	-145.447
KHOB	146	-580.048	-790.648
KHOP	147	841.754	-324.602
KHOT	148	356.115	-603.71
KHOU	149	167.118	-1147.403
KHRL	150	-67.728	-1533.473
KHRO	151	343.012	-405.722
KHSB	152	737.259	-207.858
KHUM	153	616.723	-1136.814
KHUT	154	-75.456	-213.411
KHYI	155	-84.429	-1120.581
KHYS	156	-195.165	-124.724
KIAB	157	-23.366	-263.504
KIAH	158	159.982	-1112.067
KICT	159	-36.491	-259.771
KIER	160	369.594	-908.657
KILE	161	-65.316	-988.473
KINK	162	-586.978	-890.95
KITR	163	-451.837	-69.8
KIXD	164	180.857	-126.914
KJAN	165	650.08	-826.487
KJAS	166	284.559	-1005.649
KJBR	167	569.655	-440.988
KJCT	168	-264.805	-1049.863
KJEF	169	417.469	-143.696
KJLN	170	220.368	-310.284
KJSV	171	198.556	-502.06
KJWG	172	-127.44	-456.946
KLAA	173	-494.483	-198.304
KLAW	174	-129.378	-600.254
KLBB	175	-445.079	-691.2
KLBL	176	-350.15	-318.583
KLBX	177	150.63	-1207.65
KLCH	178	366.039	-1089.113
KLFK	179	214.642	-969.288
KLFT	180	483.139	-1074.12
KLHX	181	-567.01	-195.279
KLIC	182	-573.7	-69.147
KLIT	183	434.161	-571.401
KLIX	184	691.695	-1044.752
KLLQ	185	485.203	-691.199
KLRD	186	-246.569	-1383.486
KLRU	187	-917.261	-803.759
KLVJ	188	172.567	-1160.745
KLVS	189	-731.441	-447.785
KLWC	190	153.636	-108.143
KLWV	191	809.107	-95.154

CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KLXT	192	226.086	-111.723
KLZK	193	431.199	-560.297
KMAF	194	-489.696	-878.105
KMCB	195	622.67	-955.341
KMCI	196	195.298	-73.101
KMDH	197	676.591	-216.245
KMEG	198	651.863	-512.89
KMEI	199	774.908	-814.191
KMEM	200	634.534	-523.229
KMFE	201	-125.361	-1538.535
KMHK	202	28.579	-93.934
KMKC	203	205.861	-94.951
KMKL	204	727.077	-454.381
KMKO	205	146.966	-478.029
KMLC	206	110.644	-565.417
KMLU	207	466.016	-816.792
KMNH	208	-652.817	-58.825
KMOB	209	839.42	-992.943
KMRF	210	-676.239	-1042.652
KMSL	211	853.332	-536.843
KMSY	212	653.767	-1087.37
KMTJ	213	-939.546	-109.53
KMVN	214	704.695	-154.57
KMWA	215	698.685	-218.021
KMWL	216	-99.247	-798.862
KMWT	217	312.521	-597.597
KMYP	218	-805.328	-126.737
KNEW	219	674.286	-1080.207
KNFW	220	-40.525	-801.069
KNGP	221	-28.264	-1368
KNQI	222	-81.68	-1390.219
KOCH	223	216.534	-930.592
KODO	224	-509.4	-880.305
KOJC	225	180.815	-125.068
KOKC	226	-54.186	-508.715
KOKM	227	94.479	-478.439
KOLV	228	654.146	-529.476
KOLY	229	759.691	-104.636
KOUN	230	-41.707	-526.861
KOWB	231	858.23	-202.317
KP28	232	-139.317	-297.355
KP92	233	557.13	-1172.603
KPAH	234	725.844	-291.476
KPBF	235	464.795	-631.204
KPIB	236	728.391	-915.201
KPIL	237	-33.55	-1540.831
KPNC	238	-9.037	-360.887
KPOF	239	591.592	-335.455

CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KPPF	240	130.459	-293.82
KPQL	241	814.856	-1019.221
KPRX	242	143.317	-703.629
KPSX	243	73.863	-1251.5
KPTN	244	551.151	-1123.941
KPUB	245	-651.703	-162.851
KPVJ	246	-20.054	-585.348
KPWA	247	-57.09	-493.927
KPWG	248	-30.433	-944.406
KRBD	249	12.481	-810.433
KRKP	250	-4.965	-1324.879
KRKR	251	216.017	-548.175
KROG	252	258.441	-397.719
KROW	253	-698.85	-712.895
KRQE	254	-1083.18	-409.162
KRSL	255	-156.389	-123.748
KRTN	256	-664.239	-331.996
KRUE	257	352.817	-517.944
KRVS	258	90.474	-437.23
KSAF	259	-816.558	-444.045
KSAR	260	634.139	-179.076
KSAT	261	-142.994	-1160.901
KSET	262	564.392	-97.842
KSGF	263	318.465	-299.61
KSGR	264	130.817	-1151.128
KSGT	265	495.691	-582.749
KSHV	266	298.831	-829.307
KSJT	267	-333.267	-950.677
KSKF	268	-154.653	-1177.521
KSKX	269	-770.438	-355.856
KSLG	270	224.802	-417.183
KSLN	271	-56.011	-132.485
KSLO	272	692.8	-118.63
KSNL	273	5.421	-513.325
KSPD	274	-493.802	-285.159
KSPS	275	-136.546	-666.72
KSRC	276	475.987	-516.167
KSRR	277	-789.624	-686.256
KSSF	278	-144.978	-1183.291
KSTL	279	570.065	-117.452
KSUS	280	549.336	-130.02
KSVC	281	-1043.578	-751.807
KSWO	282	-7.445	-423.979
KSWW	283	-325.719	-827.955
KTAD	284	-644.899	-276.219
KTBN	285	423.924	-237.479
KTCC	286	-597.363	-511.501
KTCL	287	870.684	-704.299

CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KTCS	288	-952.322	-695.439
KTEX	289	-948.259	-169.74
KTIK	290	-34.608	-506.971
KTKI	291	38.139	-755.127
KTOP	292	117.322	-102.315
KTPL	293	-39.799	-981.183
KTQH	294	179.315	-448.216
KTRL	295	68.48	-806.796
KTUL	296	98.267	-419.701
KTUP	297	753.906	-600.367
KTVR	298	560.687	-829.118
KTXK	299	278.022	-720.622
KTYR	300	150.418	-844.347
KUNO	301	450.268	-332.422
KUTS	302	136.314	-1024.869
KVBT	303	247.807	-399.9
KVCT	304	8.192	-1238.695
KVIH	305	454.952	-193.303
KVTP	306	-715.975	-244.241
KWDG	307	-71.289	-399.691
KWLD	308	0	-320.695
KWWR	309	-225.565	-391.327
KXNA	310	240.016	-407.886
MMRX	311	-125.617	-1557.41
KDAL	312	14.014	-791.889
KNQA	313	643.986	-489.146
MMCL	314	-1072.535	-1632.775
MMMA	315	-54.487	-1586.451
KCWF	316	371.999	-1077.296
KEAX	317	235.703	-128.032
KFWD	318	-27.846	-793.612
MMMY	319	-316.613	-1579.702
KSZL	320	297.567	-136.247
MMNL	321	-257.222	-1394.843
MMPG	322	-346.402	-1248.84
MMCS	323	-893.759	-880.938
KE33	324	-846.39	-298.154
MMAN	325	-329.872	-1569.4
MMTC	326	-660.346	-1590.033
KEND	327	-81.725	-403.278
KLRF	328	440.656	-550.693
KHMN	329	-848.745	-749.371
KAFF	330	-671.158	-85.372
KBIX	331	778.283	-1028.545
KFCS	332	-669.55	-116.96
KBAD	333	312.771	-825.1
KBYH	334	631.187	-421.631
KDYS	335	-267.671	-834.062

CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFSI	336	-127.711	-591.042
KHLR	337	-68.45	-981.004
KGVT	338	86.944	-767.36
KNMM	339	789.841	-788.597
KLTS	340	-206.759	-589.446
KRND	341	-125.115	-1161.171
MMCU	342	-882.35	-1211.961
KNBG	343	677.608	-1102.405
KCBM	344	789.252	-665.842
KPOE	345	364.89	-984.772
KDLF	346	-369.535	-1173.036
KRSN	347	413.677	-819.685
KLSX	348	544.697	-124.925
MMMV	349	-444.934	-1449.379
MMIO	350	-715.54	-1595.056
KSEP	351	-111.464	-861.645
K4T6	352	8.451	-835.284
K7F6	353	179.475	-707.745
KAWM	354	612.739	-515.624
KBKS	355	-112.415	-1422.608
KBPG	356	-425.646	-852.529
KBYY	357	111.937	-1224.526
KOSA	358	189.947	-761.973
KPYX	359	-333.955	-390.158
KT82	360	-184.545	-1081
KPVW	361	-432.871	-634.402
K25R	362	-114.5	-1509.609
K5T5	363	-9.437	-877.587
KE38	364	-643.74	-1043.615
KF05	365	-209.141	-635.991
KGYI	366	30.479	-695.167
KHHF	367	-304.913	-447.807
KHQZ	368	43.967	-802.91
KJSO	369	168.422	-899.337
KJWY	370	8.451	-835.284
KLBR	371	179.475	-707.745
KLUD	372	-53.902	-747.262
KSNK	373	-369.685	-801.662
KT53	374	-68.769	-1358.77
KRPH	375	-145.239	-761.747

ATTACHMENT A.4

CALPUFF Control File Inputs

Group	Paramater	Description	CALPUFF Input	Default	Comments
1	METRUN	Control parameter for running all periods in met. File (0=no; 1=yes)	0	0	
	IBYR	Starting year of the CALPUFF run	2002	N.A.	2001 and 2003 are the other years modeled
	IBMO	Starting month	1	N.A.	
	IBDY	Starting day	1	N.A.	
	IBHR	Starting hour	0	N.A.	
	XBTZ	Base time zone	0	N.A.	Greenwich Mean Time
	IRLG	Length of the run (hours)	8760	N.A.	2001=8760hrs, 2003=8748hrs only 12 hrs on 12/31
	NSPEC	Total number of species modeled	9	5	
	NSE	Number of species emitted	9	3	
	METFM	Meteorological data format	1	1	CALMET unformatted file
	AVET	Averaging time (minutes)	60	60	
	PGTIME	Averaging time (minutes) for PG - σ	60	60	
2	MGAUSS	Control variable determining the vertical distribution used in the near field	1	1	Gaussian
	MCTADJ	Terrain adjustment method	3	3	Partial plume path adjustment
	MCTSG	CALPUFF sub-grid scale complex terrain module (CTSG) flag	0	0	CTSG not modeled
	MSLUG	Near-field puffs are modeled as elongated "slugs"?	0	0	No
	MTRANS	Transitional plume rise modeled?	1	1	Transitional plume rise computed
	MTIP	Stack tip downwash modeled?	1	1	Yes
	MBDW	Method used to simulate building downwash?	1	1	ISC method
	MSHEAR	Vertical wind shear above stack top modeled in plume rise?	0	0	No
	MSPLIT	Puff splitting allowed?	1	0	1=Yes
	MCHEM	Chemical mechanism flag	1	1	Transformation rates computed internally (MESOPUFF II scheme)
	MAQCHEM	Aqueous phase transformation flag	0	0	Aqueous phase not modeled
	MWET	Wet removal modeled?	1	1	Yes
	MDRY	Dry deposition modeled?	1	1	Yes
	MDISP	Method used to compute dispersion coefficients	3	3	PG dispersion coefficients in RURAL & MP coefficients in urban areas
	MTURBVW	Sigma-v/sigma theta, sigma-w measurements used?	3	3	Use both sigma-(v/theta) and sigma-w from PROFILE.DAT Note: not provided
	MDISP2	Backup method used to compute dispersion when measured turbulence data are missing	3	3	PG dispersion coefficients in RURAL & MP coefficients in urban areas
	MROUGH	PG sigma-y,z adj. for roughness?	0	0	No
	MPARTL	Partial plume penetration of elevated inversion?	1	1	Yes
	MTINV	Strength of temperature inversion	0	0	No
	MPDF	PDF used for dispersion under convective conditions?	0	0	No
	MSGTIBL	Sub-Grid TIBL module used for shoreline?	0	0	No
	MBCON	Boundary conditions (concentration) modeled?	0	0	No
	MFOG	Configure for FOG model output	0	0	No
	MREG	TEST options specified to see if they conform to regulatory values?	1	1	Checks made
3	CSPEC	Species modeled	SO2, SO4, NOX, HNO3, NO3, EC, OC (SOA), PM25, PM10	N.A.	

Group	Paramater	Description	CALPUFF Input	Default	Comments
4	PMAP	Map projection	LCC	Lat Long	Lambert conformal conic
	FEAST	False Easting	0	0	
	FNORT	False Northing	0	0	
	RLATO	Latitude	40N	N.A.	
	RLONG	Longitude	97W	N.A.	
	XLAT1 XLAT2	Matching parallel(s) of latitude for projection	33N 45N	N.A.	
	DATUM	Datum region for the coordinates	WGS-G		WGS-84 GRS 80 spheroid, global coverage (WGS84)
	 NX NY NZ	Meteorological grid: No. X grid cells in meteorological grid No. Y grid cells in meteorological grid No. vertical layers in meteorological grid	 306 246 10	N.A.	
	DGRIDKM	Grid spacing (km)	6	N.A.	
	ZFACE	Cell face heights (m)	0, 20, 40, 80, 160, 320, 640, 1200, 2000, 3000, 4000	N.A.	
	XORIGKM YORIGKM	Reference coordinates of SW corner of grid cell (1,1) (km)	-1008 -1620	N.A.	
	 IBCOMP JBCOMP IECOMP JECOMP	Computational grid: X index of LL corner Y index of LL corner X index of UR corner Y index of UR corner	 1 1 306 246	N.A.	
	LSAMP IBSAMP JBSAMP IESAMP JESAMP MESHDN	- Logical flag indicating if gridded receptors are used - X index of LL corner - Y index of LL corner - X index of UR corner - Y index of UR corner - Nesting factor of the sampling grid	F 1	F	Receptors are only in the Class I areas assessed
5	SPECIES	Species (or group) list for output options	1	0	Concentrations saved for SO2, SO4, NOx, HNO3, NO3, EC, SOA, PM25, PM10
6	NHILL	Number of terrain features	0	0	
	NCTREC	Number of special complex terrain receptors	0	0	
	MHILL	Terrain and CTSG receptor data for CTSG hills input in CTDM format?	2	N.A.	Hill data created by OPTHILL & input below in subgroup (6b); receptor data in subgroup (6c) note: no data provided
	XHILL2M	Factor to convert horizontal dimensions to meters	1	1	
	ZHILL2M	Factor to convert vertical dimensions to meters	1	1	
	XCTDMKM	X-origin of CTDM system relative to CALPUFF coordinate system, in Km	0	N.A.	
	YCTDMKM	Y-origin of CTDM system relative to CALPUFF coordinate system, in Km	0	N.A.	
7	SPECIES DIFFUSVTY ALPHA STR REACTVTY MESO RES HENRYS C	Chemical parameters for dry deposition of gases	SO2 NOX HNO3 .1509 .1656 .1628 1000 1 1 8 8 18 0 5 0 .04 3.5 8.0*E-8	SO2 NOX HNO3 .1509 .1656 .1628 1000 1 1 8 8 18 0 5 0 .04 3.5 8.0*E-8	
8	SPECIES GEO. MASS DIA. GEO. SDEV.	Single species: mean and standard deviation used to compute deposition velocity for NINT size-ranges; averaged to obtain mean deposition velocity. Grouped species: size distribution specified, standard deviation as "0". Model uses deposition velocity for stated mean	SO4,NO3, EC, SOA, PM10, PM25 0.48 micron (all species) 2 microns (all species)	SO4,NO3, EC, SOA, PM10, PM25 0.48 micron (all species) 2 microns (all species)	
9	RCUTR	Reference cuticle resistance	30	30	
	RGR	Reference ground resistance	10	10	
	REACTR	Reference pollutant reactivity	8	8	
	NINT	Number of particle-size intervals to evaluate effective particle deposition velocity	9	9	
	IVEG	Vegetation state in unirrigated areas	1	1	
10	SPECIES LIQ. PRECIP. FROZ. PRECIP.	Scavenging coefficients	LIQ FROZ SO2: 3E-5 0 SO4: 1E-4 3E-5 NOX: 0 0 HNO3: 6E-5 0 NO3: 1E-4 3E-5 EC: 1E-4 3E-5 SOA: 1E-4 3E-5 PM10: 1E-4 3E-5 PM25: 1E-4 3E-5	LIQ FROZ SO2: 3E-5 0 SO4: 1E-4 3E-5 NOX: 0 0 HNO3: 6E-5 0 NO3: 1E-4 3E-5 EC: 1E-4 3E-5 SOA: 1E-4 3E-5 PM10: 1E-4 3E-5 PM25: 1E-4 3E-5	

Group	Paramater	Description	CALPUFF Input	Default	Comments
11	MOZ	Ozone data input option	1	0	
	BCKO3	Monthly ozone concentrations	0 (12 months)		
	BCKNH3	Monthly ammonia concentrations	3 (12 months)		
	RNITE1	Nighttime SO2 loss rate	0.2	0.2	
	RNITE2	Nighttime Nox loss rate	2	2	
	RNITE3	Nighttime HNO3 formation rate	2	2	
	MH2O2	H2O2 data input option	1	1	
	BCKH2O2	Monthly H2O2 concentrations	-	-	MQACHEM = 0; not used
	BCKPMF OFRAC VCNX	Secondary Organic Aerosol options	-	-	MCHEM = 1; thus, not used
12	SYTDEP	Horizontal size of puff beyond which time-dependent dispersion equations (Heffter) are used	550	550	
	MHFTSZ	Switch for using Heffter equation for sigma z as above	0	0	
	JSUP	Stability class used to determine plume growth rates for puffs above boundary layer	5	5	
	CONK1	Vertical dispersion constant for stable conditions	0.01	0.01	
	CONK2	Vertical dispersion constant for neutral/unstable conditions	0.1	0.1	
	TBD	Factor determining transition-point from Schulman-Scire to Huber-Snyder building downwash scheme	0.5	-	No building downwash used
	IURB1 IURB2	Range of land use categories for which urban dispersion is assumed	10 19	-	METFM=1; not used
	ILANDUIN	Land use category for modeling domain	20	-	METFM=1; not used
	ZOIN	Roughness length (m) for modeling domain	0.25	-	METFM=1; not used
	XLAIIN	Leaf area index for modeling domain	3	-	METFM=1; not used
	ELEVIN	Elevation above sea level	0	-	METFM=1; not used
	XLATIN	Latitude (degrees) for met location	-	-	METFM=1; not used
	XLONIN	Longitude (degrees) for met location	-	-	METFM=1; not used
	ANEMHT	Anemometer height (m)	10	-	METFM=1; not used
	ISIGMAV	Form of lateral turbulence data in PROFILE.DAT	1	Y	Read sigma-v
	IMIXCTDM	Choice of mixing heights	-	-	METFM=1; not used
	XMXLEN	Maximum length of a slug	1	1	
	XSAMLEN	Maximum travel distance of a puff/slug during one sampling step	1	1	
	MXNEW	Maximum number of slugs/puffs released from one source during one time step	99	99	
	MXSAM	Maximum number of sampling steps for one puff/slug during one time step	99	99	
	NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2	2	
	SYMIN	Minimum sigma y for a new puff/slug	1	1	
	SZMIN	Minimum sigma z for a new puff/slug	1	1	
	SVMIN SWMIN	Default minimum turbulence velocities sigma-v and sigma-w for each stability class	.5 .5 .5 .5 .5 .5 .2 .12.08 .06 .03 .016	.5 .5 .5 .5 .5 .5 .2 .12.08 .06 .03 .016	
	CDIV	Divergence criterion for dw/dz across puff used to initiate adjustment for horizontal convergence	0, 0	0, 0	
	WSCALM	Minimum wind speed allowed for non-calm conditions. Used as minimum speed returned when using power-law extrapolation toward surface	0.5	0.5	
	XMAXZI	Maximum mixing height (m)	4000		Top interface in CALMET simulation
	XMINZI	Minimum mixing height (m)	20		
	WSCAT	Default wind speed classes	1.54 3.09 5.14 8.23 10.80	1.54 3.09 5.14 8.23 10.80	
	PLXO	Default wind speed profile power-law exponents for stabilities 1-6	.07 .07 .10 .15 .35 .55	.07 .07 .10 .15 .35 .55	
	PTGO	Default potential temperature gradient for stable classes E, F (deg k/m)	.020 .035	.020 .035	
	PPC	Default plume path coefficients for each stability class	.5 .5 .5 .5 .35 .35	.5 .5 .5 .5 .35 .35	
	SL2PF	Slug-to-puff transitions criterion factor equal to sigma-v/length of slug	10	10	
	NSPLIT	Number of puffs that result every time a puff is split	3	3	May vary with simulation period (either 1 or 2)

Group	Paramater	Description	CALPUFF Input	Default	Comments
	IRESPLIT	Time of day when split puffs are eligible to be split once again; this is typically set once per day, around sunset before nocturnal shear develops	Hour 18 = 1, All others = 0		
	ZISPLIT	Split is allowed only if last hour's mixing height (m) exceeds a minimum value	100	100	
	ROLDMAX	Split is allowed only if ratio of last hour's mixing ht to the maximum mixing ht experienced by the puff is less than a maximum value	0.25	0.25	
	NSPLITH	Number of puffs that result every time a puff is split	5	5	
	SYSPLITH	Minimum sigma-y of puff before it may be split	1	1	
	SHSPLITH	Minimum puff elongation rate due to wind shear, before it may be split	2	2	
	CNSPLITH	Minimum concentration of each species in puff before it may be split	1E-7	1E-7	
	EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	1E-4	1E-4	
	EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-6	1E-6	
	DSRISE	Trajectory step-length (m) used for numerical rise integration	1	1	
	HTMINBC	Minimum height (m) to which BC puffs are mixed as they are emitted. Actual height is reset to the current mixing height at the release point if greater than this minimum	500	500	
	RSAMPBC	Search radius (in BC segment lengths) about a receptor for sampling nearest BC puff. BC puffs are emitted with a spacing of one segment length, so the search radius should be greater than 1	10		
	MDEPBC	Near-surface depletion adjustment to concentration profile used when sampling BC puffs?	1	1	Adjust concentration for depletion
13	NPT1	Number of point sources with parameters	9	N.A.	
	IPTU	Units used for point source emissions	1	1	
	NSPT1	Number of source-species combinations with variable emissions scaling factors	0	0	
	NPT2	Number of point sources with variable emission parameters provided in external file	0	N.A.	
17	NREC	Number of non-gridded receptors	120	N.A.	147 Bandelier 480 Big Bend 168 Bosque del Apache 40 Breton 80 Caney Creek 256 Carlsbad Caverns 195 Great Sand Dunes 127 Guadalupe Mountains 80 Hercules-Glades 187 La Garita 312 Mesa Verde 47 Mingo 321 Pecos 55 Salt Creek 247 San Pedro Parks 72 Upper Buffalo 744 Weminuche 109 Wheeler Peak 270 White Mountain 59 Wichita Mountains

ATTACHMENT A.5

POSTUTIL Control File Inputs

Group	Paramater	Description	POSTUTIL Input	Default	Comments	Source
1	ISYR	Starting year	2002	N.A.	2001 and 2003 also modeled	1
	ISMO	Starting month	1	N.A.		1
	IDY	Starting day	1	N.A.		1
	ISHR	Starting hour	0	N.A.	CALMET and CALPUFF in GMT; therefore, starting hour of POSTUTIL must correspond to 0 GMT	2
	NPER	Number of periods to process	8760	N.A.	2001=8760 hrs, 2003=8748 hrs (only 12 hrs on 12/31)	1
	NSPECINP	Number of species to process from CALPUFF runs	9	N.A.	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10	2
	NSPECOUT	Number of species to write to output file	9	N.A.	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10	2
	NSPECCMP	Number of species to compute from those modeled	0	N.A.		1
	MDUPLCT	Stop run if duplicate species names found?	0	0		1
	NSCALED	Number of CALPUFF data files that will be scaled	0	0		1
	MNITRATE	Re-compute the HNO3/NO3 for concentrations?	1	N	Yes, for all sources combined	1
	BCKNH3	Default ammonia concentrations used for HNO3/NO3 partition	-	N	12*3	1
2	ASPECI	NSPECINP species will be processed	-	N.A.	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10	2
	ASPECO	NSPECOUT species will be written	-	N.A.	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10	2

Notes:

[1] LDEQ, Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana, February 2007

[2] User-specified input based on CENRAP guidance (CENRAP BART Modeling Guidelines, December 2005)

ATTACHMENT A.6

CALPOST Control File Inputs

Group	Paramater	Description	CALPOST Input	Default	Comments	Source
1	METRUN	Option to run all periods found in met files	0	0	Run period explicitly defined	1
	ISYR	Starting year	2002	N.A.	2001 and 2003 also modeled	1
	ISMO	Starting month	1	N.A.		1
	IDY	Starting day	1	N.A.		1
	ISHR	Starting hour	0	N.A.	CALMET, CALPUFF, and POSTUTIL in GMT; therefore, CALPOST run must correspond to 0 GMT	2
	NHRS	Number of hours to process	8760	N.A.	2001=8760 hrs, 2003=8748 hrs (only 12 hrs on 12/31)	1
	NREP	Process every hour of data?	1	1	Every hour processed	1
	ASPEC	Species to process	VISIB	N.A.	Visibility processing	1
	ILAYER	Layer/deposition code	1	1	CALPUFF concentration	1
	A,B	Scaling factors X(new)=X(old)*A+B	0,0	0,0		1
	LBACK	Add hourly background concentrations/fluxes?	F	F		1
	MSOURCE	Option to process source contributions	0	0		1
	LG LD	Gridded receptors processed? Discrete receptors processed?	F T	N/Y	Receptors located only in the Class I areas assessed	1
	LCT	CTSG Complex terrain receptors processed?	F	F		1
	LDRING	Report results by DISCRETE receptor RING?	F	F		1
	NDRECP	Flag for all receptors after the last one assigned is set to "0"	1	1		2
	IBGRID JBGRID IEGRID JEGRID	Range of gridded receptors	-1 -1 -1 -1	-1 -1 -1 -1	When LG=T entire grid processed if all = -1	1
	NGONOFF	Number of gridded receptor rows provided to identify specific gridded receptors to process	0	0		1
	BTZONE	Base time zone for the CALPUFF simulation	0	N.A.	Greenwich Mean Time	2
	MFRH	Particle growth curve f(RH) for hygroscopic species	2	2	FLAG (2000) f(RH) tabulation. Note: not used	1
	RHMAX	Maximum relative humidity (%) used in particle growth curve	95	98	Doesn't matter, not used	1
	LVSO4 LVNO3 LVOC LVPMC LVPMF LVEC	Modeled species to be included in computing light extinction	T T T T T T	T T T T T T		1,2
	LVBK	Include BACKGROUND when ranking for TOP-N, TOP-50, and exceedance tables?	T	T		1
	SPECPMC SPECPMF	Species name used for particulates in MODEL.DAT file	PM10 PM25	N N		1
	EEPMC EEPMF	Modeled particulate species	0.6 1.0	Y Y		1
	EEPMCBK	Background particulate species	0.6	Y		1
	EESO4 EENO3 EEOC EESOIL EEEC	Other species	3.0 3.0 4.0 1.0 10	Y Y Y Y Y		1
	LAVER	Background extinction computation	F	Y		1
	MVISBK	Method used for background light extinction	6	N	Compute extinction from speciated PM measurements. FLAG RH adjustment factor applied to observed and modeled sulfate and nitrate.	1
	RHFAC	Extinction coefficients for hygroscopic species (modeled and background). Monthly RH adjustment factors.	-	N.A.	See Table 4 in main protocol document	1
	BKSO4 BKNO3 BKPMC BKOC BKSOIL BKEC	Monthly concentrations of ammonium sulfate, ammonium nitrate, coarse particulates, organic carbon, soil and elemental carbon to compute background extinction coefficients	-	N.A.	See Table 5 in main protocol document	1
	BEXTRAY	Extinction due to Rayleigh scattering (1/Mm)	10	Y		1
	IPRTU	Units for all output	3	N	micrograms/cubic meter	1
	L24HR	Averaging time reported	T	N.A.		1
	LTOPN	Visibility: Top "N" table for each averaging time selected.	F	Y		1
	NTOP	Number of "Top-N" values at each receptor selected (NTOP must be <=4)	4	Y		1
	MDVIS	Output file with visibility change at each receptor?	0	Y	Create file of DAILY (24 hour) delta-deciview. Grid model run.	1

Notes:

[1] LDEQ, Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana, February 2007

[2] User-specified input based on CENRAP guidance (CENRAP BART Modeling Guidelines, December 2005)

ATTACHMENT A.7

Modeling Archive

Attachment A.7, Table 1: File Naming Convention

Model	File Type	File Name	Notes
CALPUFF	Input	2001a.cpi	2880 hrs – 1/1 – 4/30
		2001b.cpi	3024 hrs – 4/28 – 8/31
		2001c.cpi	2952 hrs – 8/29 – 12/31
		2002.cpi	8760 hrs
		2003.cpi	8748 hrs (only 12 hrs on 12/31)
POSTUTIL	Input	2001a_sid_rich_postutil.inp	2880 hrs – 1/1 – 4/30
		2001b_sid_rich_postutil.inp	3024 hrs – 4/28 – 8/31
		2001c_sid_rich_postutil.inp	2952 hrs – 8/29 – 12/31
		2002_sid_rich_postutil.inp	8760 hrs
		2003_sid_rich_postutil.inp	8748 hrs (only 12 hrs on 12/31)
APPEND	Input	Append.inp	2001
CALPOST	Input	2001_sid_rich_bret_cpst.inp	Breton Wilderness Area
		2001_sid_rich_cacr_cpst.inp	Caney Creek Wilderness Area
		2002_sid_rich_bret_cpst.inp	Breton Wilderness Area
		2002_sid_rich_cacr_cpst.inp	Caney Creek Wilderness Area
		2003_sid_rich_bret_cpst.inp	Breton Wilderness Area
		2003_sid_rich_cacr_cpst.inp	Caney Creek Wilderness Area
CALPUFF	Output	2001a.con	Concentration
		2001a.dry	Dry deposition
		2001a.wet	Wet deposition
		2001b.con	Concentration
		2001b.dry	Dry deposition
		2001b.wet	Wet deposition
		2001c.con	Concentration
		2001c.dry	Dry deposition
		2001c.wet	Wet deposition
		2002.con	Concentration
		2002.dry	Dry deposition
		2002.wet	Wet deposition
		2003.con	Concentration
		2003.dry	Dry deposition
		2003.wet	Wet deposition
POSTUTIL	Output	2001a_sid_rich_cpuf.dat	Concentration
		2001a_sid_rich_postutil.lst	List file
		2001b_sid_rich_cpuf.dat	Concentration
		2001b_sid_rich_postutil.lst	List file
		2001c_sid_rich_cpuf.dat	Concentration
		2001c_sid_rich_postutil.lst	List file
		2002_sid_rich_cpuf.dat	Concentration
		2002_sid_rich_postutil.lst	List file
		2003_sid_rich_cpuf.dat	Concentration

Attachment A.7, Table 1: File Naming Convention

Model	File Type	File Name	Notes
POSTUTIL	Output	2003_sid_rich_postutil.lst	List file
APPEND	Output	2001_sid_rich_cpuf.dat	Concentration - appended
		Append.lst	List file
CALPOST	Output	2001_sid_rich_bret_cpst.lst	Breton Wilderness Area
		2001_sid_rich_cacr_cpst.lst	Caney Creek Wilderness Area
		2002_sid_rich_bret_cpst.lst	Breton Wilderness Area
		2002_sid_rich_cacr_cpst.lst	Caney Creek Wilderness Area
		2003_sid_rich_bret_cpst.lst	Breton Wilderness Area
		2003_sid_rich_cacr_cpst.lst	Caney Creek Wilderness Area

APPEND Discussion

Because of file size limitations, the CALPUFF simulation for 2001 was split into three separate CALPUFF runs (2001a, 2001b, and 2001c). When applying CALPUFF separately with meteorology that is split into multiple consecutive time periods, it is necessary to account for puffs that are remaining at the end of one time period in the next time period.9 This is achieved by modeling overlapping time periods. Therefore, the 2001b and 2001c CALPUFF runs begin with 3 days of meteorology from the end of the previous month. For example, the 2001b CALPUFF run begins on April 28, 2001, instead of May 1, 2001. Similarly, the 2001c CALPUFF run begins on August 29, 2001, instead of September 1, 2001.

The APPEND program can be used to append the sequential output data files into a single file for CALPOST processing. Output data files for 2001a, 2001b, and 2001c are appended to produce the 2001 output data file. Overlapping time periods are not a problem because the user can specify the number of hours to skip at the beginning and the total number of hours to read from each file. For this project, 72 hours (3 days) were skipped at the beginning of the 2001b and 2001c data files. The resulting output data file is 8760 hours in length.

9 http://www.src.com/calpuff/FAQ-answers.htm#4.2.1

ATTACHMENT B

Description of NO_X Control Technologies

Table 3. External Combustion NOx Limiting Technologies

Technique	Description	Advantages	Disadvantages	Impacts	Applicability
Less Excess Air (LEA)	Reduces oxygen availability	Easy modification	Low NOx reduction	High CO Flame length Flame stability	All fuels
Off Stoichiometric a. Burners Out of Service (BOOS) b. Over Fire Air (OFA)	staged combustion	Low cost No capital cost for BOOS	a. Higher air flow for CO b. high capital cost	Flame length Fan capacity Header pressure	All fuels Multiple burners for BOOS
Low NOx Burner (LNB)	Internal staged combustion	Low operating cost Compatible FGR	Moderately high capital cost	Flame length Fan capacity Turndown stability	All fuels
Flue Gas Recirculation (FGR)	<30% flue gas recirculated with air, decreasing temperature	High NOx reduction potential for low nitrogen fuels	Moderately high capital cost and operating cost Affects heat transfer and system pressures	Fan capacity Furnace pressure Burner pressure drop Turndown stability	All fuels Low nitrogen fuels
Water/Steam Injection	Reduces flame temperature	Moderate capital cost NOx reduction similar to FGR	Efficiency penalty Fan power higher	Flame stability Efficiency penalty	All fuels as Low nitrogen fuels
Reduced Air Preheat	Air not preheated, reduces flame temperature	High NOx reduction potential	Significant efficiency loss (1% per 40°F)	Fan capacity Efficiency penalty	All fuels Low nitrogen fuels
Selective Catalytic reduction (SCR) (add-on technology)	Catalyst located in the air flow, promotes reaction between ammonia and NOx	High NOx removal	Very high capital cost High operating cost Catalyst siting Increased pressure drop Possible water wash required	Space requirements Ammonia slip Hazardous waste Disposal	All fuels

Table 3. External Combustion NOx Limiting Technologies

Technique	Description	Advantages	Disadvantages	Impacts	Applicability
Selective Non-Catalytic Reduction (SNCR) (add-on technology) a. urea b. ammonia	Inject reagent to react with NOx	a. Low capital cost Moderate NOx removal Non-toxic chemical b. Low operating cost Moderate NOx removal	a. Temperature dependent NOx reduction less at lower loads b. Moderately high capital cost Ammonia storage, handling, injection system	a. Furnace geometry Temperature profile b. Furnace geometry Temperature profile	All fuels
Fuel Reburning	Inject fuel to react with NOx	Moderate cost Moderate NOx removal	Extends residence time	Furnace temperature profile	All fuels (pulverized solid)
Combustion Optimization	Change efficiency of primary combustion	Minimal cost	Extends residence time	Furnace temperature profile	Gas Liquid fuels
Catalytic Combustion	Catalyst causes combustion to be at low temperature	Lowest possible NOx	Very high capital cost High operating cost Catalyst siting	Space requirements Disposal	Gas Liquid fuels
Non-Thermal Plasma	Reducing agent ionized or oxidant created in flow	Moderate cost Easy siting High NOx removal	Fouling possible Ozone emission possible	Uses electrical power	All fuels
Inject Oxidant	Chemical oxidant injected in flow	Moderate cost	Nitric acid removal	Add-on	All fuels
Oxygen instead of Air	Uses oxygen to oxidize fuel	Moderate to high cost Intense combustion	Eliminates prompt NOx Furnace alteration	Equipment to handle oxygen	All fuels
Ultra-Low Nitrogen Fuel	Uses low -nitrogen fuel	Eliminates fuel NOx No capital cost	Slight rise in operating cost	Minimal change	All ultra-low nitrogen fuels

Table 3. External Combustion NOx Limiting Technologies

Technique	Description	Advantages	Disadvantages	Impacts	Applicability
Use Sorbents (add-on technology) in: a. Combustion b. Duct to Baghouse c. Duct to Electrostatic Precipitator	Use a chemical to absorb NOx or an adsorber to hold it	Can control other pollutants as well as NOx Moderate operating cost	Cost of handling sorbent Space for the sorbent storage and handling	Add-on	All fuels
Air Staging	Admit air in separated stages	Reduce peak combustion temperature	Extend combustion to a longer residence time at lower temperature	Adds ducts and dampers to control air Furnace modification	All fuels
Fuel Staging	Admit fuel in separated stages	Reduce peak combustion temperature	Extend combustion to a longer residence time at lower temperature	Adds fuel injectors to other locations Furnace modification	All fuels

EXTERNAL COMBUSTION: POLLUTION PREVENTION METHODS

LESS EXCESS AIR (LEA)

Excess air flow for combustion has been correlated to the amount of NOx generated. Limiting the net excess air flow to under 2% can strongly limit NOx content of flue gas. Although there are fuel-rich and fuel-lean zones in the combustion region, the overall net excess air is limited when using this approach.[43]

BURNERS OUT OF SERVICE (BOOS)

Multiple-burner equipment can have part of an array of burners with some "burners out of service" (not feeding fuel, but supplying air or flue gas). This allows the burners around them to supply fuel and air to air or flue gas flowing from the BOOS. The result is combustion by stages with temperature always lower than when all burners are in service. Thus, thermal NOx is lower. The degree to which NOx generation is reduced depends upon the spatial relationship of the BOOS to the other burners.[44]

OVER FIRE AIR (OFA)

When primary combustion uses a fuel-rich mixture, use of OFA completes the combustion. Because the mixture is always off-stoichiometric when combustion is occurring, the temperature is held down. After all other stages of combustion, the remainder of the fuel is oxidized in the over fire air. This is usually not a grossly excessive amount of air.

LOW NOx BURNERS (LNB)

A LNB provides a stable flame that has several different zones. For example, the first zone can be primary combustion. The second zone can be Fuel Reburning (FR) with fuel added to chemically reduce NOx. The third zone can be the final combustion in low excess air to limit the temperature. There are many variations on the LNB theme of reducing NOx. The LNB has produced up to 80% DRE.[17,18,32,33] This can be one of the least expensive pollution prevention technologies with high DRE. LNB have had problems with designs that had flame attaching to the burners, resulting in a need for maintenance. We believe that these design problems should now be a thing of the past.

FLUE GAS RECIRCULATION (FGR)

Recirculation of cooled flue gas reduces temperature by diluting the oxygen content of combustion air and by causing heat to be diluted in a greater mass of flue gas. Heat in the flue gas can be recovered by a heat exchanger. This reduction of temperature lowers the NOx concentration that is generated. If combustion temperature is held down to below 1,400°F, the thermal NOx formation will be negligible.[50]

WATER OR STEAM INJECTION

Injection of water or steam causes the stoichiometry of the mixture to be changed and adds steam to dilute calories generated by combustion. Both of these actions cause combustion temperature to be lower. If temperature is sufficiently reduced, thermal NOx will not be formed in as great a concentration.

REDUCED AIR PREHEAT

Air is usually preheated to cool the flue gases, reduce the heat losses, and gain efficiency. However, this can raise the temperature of combustion air to a level where NOx forms more readily. By reducing air preheat, the combustion temperature is lowered and NOx formation is suppressed. This can lower efficiency, but can limit NOx generation.

FUEL REBURNING (FR)

Recirculation of cooled flue gas with added fuel (this can be natural gas, pulverized coal, or even oil spray) causes dilution of calories, similar to FGR, and primary combustion temperature can be lowered. Also, when added as a secondary combustion stage, the presence of added fuel chemically reduces newly generated NOx to molecular nitrogen. Added fuel is only partially consumed in reducing NOx and burning is completed in a later stage using either combustion air nozzles or over-fire-air. This technique has been demonstrated to be effective with residence times from 0.2 seconds to 1.2 seconds and has achieved up to 76% DRE. [17]

COMBUSTION OPTIMIZATION

Combustion optimization refers to the active control of combustion. In a natural gas fired boiler, by decreasing combustion efficiency from 100% to 99%, NOx generation dropped to a much more acceptable level.[14,15] For coal-fired boilers a 20% to 60% reduction in NOx has been experienced. These active combustion control measures seek to find an optimum combustion efficiency and to control combustion (and hence emissions) at that efficiency. Another approach uses a neural network computer program to find the optimum control point.[16] Still another approach is to use software to optimize inputs for the defined output.[52,53]

One vendor decreases the amount of air that is pre-mixed with fuel from the stoichiometric ratio (ratio that produces the hottest flame) to lengthen the flame at the burner and reduce the rate of heat release per unit volume. This can work where the boiler tubes are far enough away from the burner. Carbon monoxide, unburned fuel, and partially burned fuel that result can then be subsequently oxidized in over-fire-air at a lower temperature. Combustion must be optimized for the conditions that are encountered. 50% DRE has been reported.[14]

AIR STAGING

Combustion air is divided into two streams. The first stream is mixed with fuel in a ratio that produces a reducing flame. The second stream is injected downstream of the flame and makes the net ratio slightly excess air compared to the stoichiometric ratio. DRE up to 99% have been reported.[51]

FUEL STAGING

This is staging of combustion using fuel instead of the air. Fuel is divided into two streams. The first stream feeds primary combustion that operates in a reducing fuel to air ratio. The second stream is injected downstream of primary combustion, causing the net fuel to air ratio to be only slightly oxidizing. Excess fuel in primary combustion dilutes heat to reduce temperature. The second stream oxidizes the fuel while reducing the NOx to N_2. This is reported to achieve a 50% DRE.[51]

OXYGEN INSTEAD OF AIR FOR COMBUSTION

An example of this is a cyclone burner where the flame is short and intense. Excess fuel air or steam, injected just after the combustion chamber per Method 2 is sufficient to rapidly quench the flue gas to below NOx formation temperature. Combustion can then be completed in over-fire air. Oxygen can now be separated from air at a low enough cost to make this economical.[13] This technique has reduced NOx by up to 20%[23] in burners using conventional fuel. This technique also is usable with low-NOx burners to prevent the prompt NOx from being formed.

INJECTION OF OXIDANT

The oxidation of nitrogen to its higher valence states makes NOx soluble in water. When this is done a gas absorber can be effective. Oxidants that have been injected into the air flow are ozone, ionized oxygen, or hydrogen peroxide. Non-thermal plasma generates oxygen ions within the air flow to achieve this. Other oxidants have to be injected and mixed in the flow. Nitric acid can be absorbed by water, hydrogen peroxide, or an alkaline fluid. Calcium or ammonia dissolved in the water can make an alkaline fluid that will react with nitric and sulfuric acids to produce a nitrate or sulfate salt that can be recovered. Alternatively, using water or hydrogen peroxide to absorb NOx can provide nitric acid for the commercial market.

CATALYTIC COMBUSTION

Use of a catalyst to cause combustion to occur below NO formation temperatures can provide a suitable means of limiting temperature. This technique is not used often because it is very load sensitive. However, where it is used, catalytic combustion can achieve less than a 1 ppm concentration of NOx in the flue gas.

ULTRA-LOW NITROGEN FUELS

These fuels can avoid NOx that results from nitrogen contained in conventional fuels. The result can be up to a 70% reduction in NOx emissions.[43] Now there are ultra-low-nitrogen liquid fuel oils. These oils contain 15-20 times less nitrogen than standard No. 2 fuel oil. This oil is now commercially available and competitively priced. Ultra-low-nitrogen oil is most frequently used in Southern California where the air pollution is particularly a problem. Natural gas can be considered a low-nitrogen fuel. Coke (the quenched char from coal) can also be an ultra-low-nitrogen fuel because nitrogen in the volatile fraction of the coal is removed in making coke.

NON-THERMAL PLASMA

Using methane and hexane as reducing agents, non-thermal plasma has been shown to remove NOx in a laboratory setting with a reactor duct only 2 feet long. The reducing agents were ionized by a transient high voltage that created a non-thermal plasma. The ionized reducing agents reacted with NOx and achieved a 94% DRE. There are indications that an even higher DRE can be achieved. A successful commercial vendor uses ammonia as a reducing agent to react with NOx in an electron beam generated plasma. Such a short reactor can meet available space requirements for virtually any plant. The non-thermal plasma reactor could also be used without reducing agent to generate ozone and use that ozone to raise the valence of nitrogen for subsequent absorption as nitric acid.

EXTERNAL COMBUSTION: ADD-ON CONTROL TECHNOLOGY

Add-on controls are applicable to a broad range of sources and fuels. This differs from the pollution prevention techniques listed above in that the prevention techniques must be adapted to the circumstances of their use.

SELECTIVE CATALYTIC REDUCTION (SCR)

SCR uses a catalyst to react injected ammonia to chemically reduce NOx. It can achieve up to a 94% DRE[34] and is one of the most effective NOx abatement techniques. However, this technology has a high initial cost. In addition, catalysts have a finite life in flue gas and some ammonia "slips through" without being reacted. SCR has historically used precious metal catalysts, but can now also use base-metal and zeolite catalysts. The base-metal and zeolite catalysts operate at much different temperatures then the precious metal catalysts.[11]

SELECTIVE NON-CATALYTIC REDUCTION (SNCR)

In SNCR ammonia or urea is injected within a boiler or in ducts in a region where temperature is between 900°C and 1100°C. This technology is based on temperature ionizing the ammonia or urea instead of using a catalyst or non-thermal plasma. This temperature "window" – which is reported differently by various authors -- is important because outside of it either more ammonia "slips" through or more NOx is generated than is being chemically reduced. The temperature "window" is different for urea and ammonia. Reduction of the NOx by SNCR can have up to a 70% DRE.[23,35,43]

SORPTION – BOTH ADSORPTION AND ABSORPTION

Several methods are used to inject and remove adsorbent or absorbent. One method sprays dry powdered limestone into the flue gas. The limestone then reacts with both sulfuric acid and nitric acid. There also is a spray dryer approach that sprays a slurry of powdered limestone and aqueous ammonia into the flue gas. The limestone preferentially reacts with the sulfur while the ammonia preferentially reacts with the NOx. In-duct injection of dry sorbents is another example of this technique and can reduce pollutants in three stages: (1) in the combustion chamber, (2) in the flue gas duct leading to the baghouse, and (3) in the flue gas duct leading to the electrostatic precipitator. The by products formed by sorption are gypsum (calcium sulfate) that is sold to make wallboard, and ammonium nitrate that can be sold to make either an explosive or a fertilizer. Sorption is reported to have up to a 60% DRE.[23, 31] Another version uses carbon injected into the air flow to finish the capture of NOx. The carbon is captured in either the baghouse or the ESP just like other sorbents. There are many absorbents and adsorbents available.

COMBINED TECHNOLOGY APPROACHES

Very seldom is only one method or principle used alone. The choice depends upon the type of combustion system, type of boiler or other energy conversion device, and type of fuel used. Available technologies will be narrowed by consideration of turndown ratio, stability of combustion, availability or access to burners, air supply controls, fuel impurities, and cost among other factors.

There are many examples and here are a few of them. Selective catalytic reduction of NOx to N_2 can be followed by selective oxidation of sulfur dioxide to sulfur trioxide. Then sulfuric acid is formed followed by scrubbing sulfuric acid from the flue gas.[30]

LNB can be used in conjunction with SCR or SNCR to achieve a greater overall DRE than any of these can achieve alone. Water/steam injection can be used with SCR to achieve a DRE greater than SCR can achieve alone. Fuel reburning and SCR can be used together as well as separately, to get the maximum NOx reduction.[57]

INTERNAL COMBUSTION

Now we turn to internal combustion, which usually occurs at elevated pressures. Again, we divide the technologies between pollution prevention techniques and add-on technologies. This is shown in Table 4.

These techniques can be used in combination. Pollution prevention techniques do not have to be used separately. Add-on techniques could be used sequentially after a pollution prevention technique when they do not impose conflicting demands on the process.

ATTACHMENT C

January 2006 BACT Analysis Performed for the Addis Plant

Sid Richardson Carbon, Ltd.
Addis, Louisiana

Part 70 Permit Modification and PSD Permit Application

Agency Interest No. 4174

January 27, 2006

Project No. 0028686-2

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Table 3.3-1 Project Emission Increases & PSD/NNSR Applicability Thresholds			
Pollutant	**Project Emission Increases (tons/yr)**	**PSD Applicability Threshold (tons/yr)**	**NNSR Applicability Threshold (tons/yr)**
CO	496.2	100	NA
SO_2	2,134.0	40	NA
PM_{10}	-6.9	15	NA
H_2S	5.5	10	NA
TRS (including H_2S)	12.8	10	NA
VOC	14.9	40	25
NOx	24.3	40	25

Past actual emissions and detailed project emission increases are shown in the PSD and NNSR netting analysis found in Appendix L.

3.3.3 *Air Quality Impacts*

Air quality impacts must be evaluated for each regulated pollutant with increased emissions greater than the PSD significance level. These increases must be modeled to evaluate the potential impacts on the air quality in the surrounding area.

3.3.4 *Other Impacts*

The results from the PSD air quality modeling will be used to determine any additional impacts (i.e., soil, vegetation, visibility, etc.) that could result from this permit amendment.

3.3.5 *Control Technology Review*

An independent BACT review was performed for each pollutant subject to PSD review (CO, TRS and SO_2). Control technologies were evaluated based on the technical and economic feasibility to determine BACT for each pollutant according to technologies approved for similar changes in carbon black plants.

3.3.5.1 *Previous Determinations of BACT*

As a first step, the EPA's RACT, BACT, LAER Clearinghouse (RBLC) was queried for recent permits for the carbon black industry. The identified controls would be considered BACT provided no new technical developments had occurred since the permit was issued.

Summaries of the BACT determinations are provided in Appendix M and listed in Table 3.3-2.

The review of EPA's RACT/BACT/LAER Clearinghouse (RBLC) revealed that BACT for CO has basically been flares/thermal oxidizer, with 98% destruction efficiency and the BACT for TRS has basically been good combustion practice, with 98% to 99.98% destruction efficiency. The review also revealed that controlling the sulfur content of the feedstock oil, rather than add-on sulfur reduction technology, has been considered BACT for SO_2. No add-on SO_2 controls have ever been considered BACT for the carbon black industry.

The results of this query are also summarized in Table 3.3-2. As discussed below, the controls proposed by SRC employ the best available control technology currently used for carbon black sources.

3.3.5.2 *Carbon Monoxide (CO)*

As shown in Table 3.3-2, BACT for carbon monoxide is good combustion practice, with 98% destruction efficiency. SRC proposes to continue routing tail gas streams to combustion devices obtaining at least 98% efficiency.

3.3.5.3 *Total Reduced Sulfur (TRS)*

As shown in Table 3.3-2, BACT for total reduced sulfur compounds is good combustion practice, with 98% to 99.98% destruction efficiency. SRC proposes to continue routing tail gas streams to combustion devices obtaining at least 99% combustion efficiency.

3.3.5.4 *Sulfur Dioxide (SO_2)*

As shown in Table 3.3-2, BACT for SO_2 is based on a limitation of sulfur in CBO feedstock, with approved sulfur contents ranging from 1.25% to 4%. SRC has determined that BACT for the Addis plant is an annual average feedstock sulfur limit of 3.0% with a maximum not to exceed 3.2% on a 60-day rolling average. A top-down BACT analysis (consistent with other analyses conducted for other carbon black plants) was performed for the Addis plant and is presented below.

3.3.5.4.1 *Technical Feasibility*

Sulfur removal technologies and a summary of their technical feasibility are included in Table 3.3-3. Technologies determined to be technically feasible, in addition to limiting feedstock sulfur content, were an adsorption process by Selective Adsorption Associates, Inc., the DynaWave System using limestone or caustic scrubbing material by Monsanto-Envirochem, and the SNOX sulfur recovery/conversion process by Haldor Topsoe. The remaining options listed in Table 3.3-3 were unproven for this application, and the vendors declined to provide cost or performance data.

Table 3.3-3

Technological Feasibility of Control Options

Technology	Company	Technically Feasible?
SCOSOx	Goal Line Environmental Technologies	No. Vendor cannot guarantee a control efficiency for the technology. Also, halides, which are present in the off-gas, are known catalyst deactivators.
Adsorption	Selective Adsorption Associates, Inc.	Yes.
TurboSonic (SO2 Removal) - Adsorption	TurboSonic Inc.	[1]
FLEXSORB	Exxon	[1]
Regenerative gas desulfurization	Cansolve Technologies, Inc.	[1]
H2S removal	Paques Thiopaq Bioscrubber	[1]
Limestone or Caustic Scrubber	Monsanto-Envirochem	Yes.
Wet gas scrubbers	Belco	Unknown
E-LIDS (limestone injection)	McDermott Technology, Inc. (Babcock and Wilcox)	[1]
Claus	Ortloff Engineers, LTD	No. Vendor replied that the technology would not be suitable for pre-combustion treating of the off-gas which contains oxygen.
SNOX	Haldor Topsoe	Yes.
Selective Non-catalytic Reduction (SNCR)	Fuel Tech	No. Vendor stated that the SNCR is a NOx-reduction technology; not a control solution for sulfur reduction.
Sulferox	Dow Chemical	[1]
Flue Gas Deacidification	Eagle Air Pollution Control	[1]

[1] Given that this is an unproven technology for this application, the vendor declined to provide any cost or performance guarantees.

3.3.5.4.2 *Economic Analysis of Technically Feasible Options for SO_2 Control*

The economic reasonableness of the technologies determined to be technically feasible is investigated in this section.

Reduction of Sulfur in Feedstock
A survey of carbon black feedstock suppliers revealed a variety of costs associated with various sulfur contents and carbon yields. The costs obtained reflect the current supply/demand balance and are not expected to reflect the higher costs that SRC would pay on an ongoing basis (due to a shift in the supply/demand equilibrium). The availability of the low sulfur oil from these refiners/brokers is highly uncertain, and if demand for the lower sulfur oil increases there would be dramatic increases in cost.

As a result of Hurricanes Katrina and Rita and other regulatory changes that impact the refining industry, the price differential between low and high sulfur feedstock has been increased dramatically. The price differential between 1% S and 3% S feedstock oil has recently approached $13.00 per barrel. As shown in Table 3.3-4, the cost differential for using 1% S feedstock instead of 3% S feedstock equates to $2,418 per ton of SO_2 reduced. This cost is not economically feasible.

Adsorption Process by Selective Adsorption Associates, Inc.
The vendor for this technology stated that the non-regenerative adsorption technology is not economical for this application. The adsorbent costs $2/pound and the required daily adsorbent usage would be 1.5 million pounds for Addis or $3 million per day. This option was determined to not be economically reasonable.

Table 3.3-4
Example BACT Cost Analysis for Carbon Black SO_2
Based on Substituting 3% S Feed with 1% S Feed

Parameter	Value	Units
Percent Sulfur in Feed Emitted as SO_2	80	wt%
Feedstock Density	336	lb/bbl
Sulfur Contained in 1 bbl of 3% S Feedstock	10.08	lb S/bbl
SO_2 Emitted from 1 bbl of 3% S Feedstock	16.13	lb SO_2/bbl
Sulfur Contained in 1 bbl of 1% S Feedstock	3.36	lb S/bbl
SO_2 Emitted from 1 bbl of 1% S Feedstock	5.38	lb SO_2/bbl
Reduction of SO_2 by Substituting 3% S Feed with 1% S Feed	10.75	lb SO_2/bbl
bbl of Substituted Feedstock Needed for a 1 ton SO_2 Reduction	186.0	bbl /ton SO_2
Cost differential between 1% S feedstock and 3% S feedstock	13.00	$/bbl
Cost per ton of SO_2 Reduced	2,418	$/ton SO_2 reduced

DynaWave System by Monsanto Enviro-Chem

The DynaWave system can be operated as either a caustic or limestone scrubbing system. Both systems rely on the same basic equipment with differences to accommodate the specific raw and waste materials for each scrubbing material.

Major equipment costs quotes were provided equipment manufacturers for similar installations at a carbon black manufacturing facilities. These quotes were adjusted to account for both inflation and changes in equipment size due to tail gas flow rates.

EPA's OAQPS Control Cost Manual was used for factors to determine additional installation costs. Costs for ductwork, site preparation, raw material storage tanks, and unloading stations were calculated for each of the adsorbents. Costs for ductwork were estimated assuming tail gas will be combusted in the existing combustion devices (flares and dryers) and then routed to the control device.

Slurry filters are used downstream of the scrubbers to either de-water the sludge, in the case of limestone, or remove solids before discharge, in the case of caustic. The costs of these filters were estimated using Wastewater Treatment Plant Cost Curves from Wastewater Treatment Plants, Planning, Design, and Operation[1], adjusted for inflation.

Waste materials from the limestone process will be landfilled after de-watering. The capital cost for an on-site landfill (including solid waste permit, liner and monitoring system) and the annual operating expense were calculated and compared to the cost for off-site landfill disposal. An on-site landfill was determined to be overall lower cost. For the caustic process, the waste material will be treated and discharged under an NPDES permit. Since the facility currently does not have a wastewater treatment facility sufficient to handle these wastes, the cost for design, construction, and permitting as well as operating costs were included.

Other miscellaneous costs include heat tracing of exposed lines for freeze protection, upgrade of roads to handle additional traffic (due to raw material delivery and waste disposal) and performance testing.

As shown in Table 3.3-5, the total capital cost for the caustic scrubbing is approximately $4.3 million. The total capital cost for limestone scrubbing is $4.6 million.

[1] Qasim, Syed R. Wastewater Treatment Plants, Planning, Design and Operation, Appendix C, Figure C-15, p. 687.

Table 3.3-5
SO2 Control Technology Capital Control Costs

Direct Costs	Caustic Scrubbing	Limestone Scrubbing	SNOX
Purchased Equipment Cost, A	$1,398,510	$1,617,599	$19,555,471
Instrumentation, 0.1A	$139,851	$161,760	$1,955,547
Ductwork and Dampers	$896,277	$896,277	$896,277
Sales Taxes, 0.05A	$69,926	$80,880	$977,774
Freight 0.05A	$69,926	$80,880	$977,774
Slurry filters	$236,889	$205,395	NA
Total Purchased Equipment cost, B	$2,811,379	$3,042,791	$24,362,842
Direct Installation Costs			
Foundation and	$224,910	$243,423	$1,949,027
Handling and erection,	$393,593	$425,991	$3,410,798
Electrical, 0.04B	$112,455	$121,712	$974,514
Piping, 0.02B	$56,228	$60,856	$487,257
Insulation for ductwork,	$28,114	$30,428	$243,628
Painting, 0.01B	$28,114	$30,428	$243,628
Total Direct Installation Costs	$843,414	$912,837	$7,308,853
Site Preparation and Permitting			
Loading station	$250,000	$250,000	$250,000
Storage tanks	$44,919	$21,665	$188,241
Class I landfill startup	NA	$250,000	NA
Wastewater	$250,000	NA	NA
Heat trace all exposed	$50,000	$50,000	$100,000
Road improvements	$25,852	$25,852	$25,852
Total Direct Cost	$4,275,563	$4,553,145	$32,235,788
Indirect Costs (installation)			
Engineering, 0.1B	$281,138	$304,279	$2,436,284
Construction and field	$140,569	$152,140	$1,218,142
Contractor fees, 0.1B	$281,138	$304,279	$2,436,284
Start-up, 0.02B	$56,228	$60,856	$487,257
Performance test, 0.01B	$28,114	$30,428	$243,628
Contingencies, 0.10B	$281,138	$304,279	$2,436,284
Total Indirect Cost	$1,068,324	$1,156,261	$9,257,880
Total Capital Investment = DC +	$5,343,887	$5,709,405	$41,493,668

As shown in Table 3.3-6, annual operating cost for caustic scrubbing (including recovery of capital) is $8.3 million. Annual operating cost for limestone scrubbing (including recovery of capital) is $3.9 million. This technology was determined to not be economically feasible.

SNOX Process by Haldor Topsoe

The capital and operating costs for the SNOX process were provided by the vendor. In addition to the purchased equipment, additional equipment and installation was estimated using the OAQPS Control Cost Manual. This includes the cost for foundations, instrumentation, electrical, piping, and insulation. The costs for an ammonia loading station and storage tanks for both raw materials and produced sulfuric acid were also included. The volume of ammonia required will cause SRC to be subject to process safety management requirements. This will necessitate at least one additional engineer and one technician as well as extra testing, etc.

Operating costs for the SNOX process included all necessary labor and raw material costs. Costs also include expected profit realized from the sale of produced sulfuric acid and recovery of the capital costs associated with the installation, based on a 10 year life.

As shown in Tables 3.3-5 and 3.3-6, the total capital cost for the SNOX process is approximately $32.2 million, and the annual operating cost for the SNOX process (including recovery of capital) is $12.8 million. This technology was determined to not be economically feasible.

Table 3.3-6
SO2 Control Technology Annual Control Costs

	Suggested Factor		Unit Cost		Caustic Scrubbing	Limestone Scrubbing	SNOX
Direct Annual Costs							
Operating Labor							
Caustic (includes wastewater)	8	hours/shift	$20.32	per hour	$178,008	NA	NA
Limestone (includes landfill)	4	hours/shift			NA	$89,004	NA
SNOX	16	hours/shift			NA	NA	$356,016
Supervisor	15%	of operator			$26,701	$13,351	$53,402
Operating Materials							
Chemicals							
Ammonia	409	tons/year	$192	per ton	NA	NA	$78,508
Transporation	22	loads/yr	$113	per load	NA	NA	$2,431
SCR Catalyst	61.5	m3/ 6 years	$18,063	per m3	NA	NA	$290,856
SO2 Catalyst	391.0	m3/ 5 years	$4,064	per m3	NA	NA	$477,878
NaOH	1864.7	lb/hr	$0.1270	per dry lb NaOH	$2,074,575	NA	NA
Transporation	430	loads/yr	$903	per load	$388,225	NA	NA
Limestone	2333.2	lb/hr	$0.0141	per dry lb limestone	NA	$288,417	NA
Transporation	538	loads/yr	$903	per load	NA	$485,754	NA
Slurry filters					$21,000	$22,000	NA
Subtotal					$2,462,800	$774,171	$849,673
Disposal							
Solid waste							
Spent Limestone	3,930	lb/hr	$45	per ton	NA	$777,238	NA
Wastewater							
Spent Caustic	1,899	gph	$0.11	per gal	$1,877,682	NA	NA
Maintenance							
Labor	1.0	hours/shift	$20.32	per hour	$22,251	$22,251	$22,251
Material	1%	Purchase Eq.			$28,114	$30,428	$243,628
Roadways					$6,350	$6,350	$6,350
Utilities							
Natural Gas	23.38	MM Btu/hr	$5	per MM Btu	NA	NA	$924,956
Electric Power	Varies for all 3		$0.07	per kWhr	$82,712	$88,049	$892,440
Cooling/Makeup Water	Varies for all 3		$1.69	per 1000 gal	$981	$448	$27,412
Subtotal					$83,694	$88,497	$1,844,808
Sale of Waste Product	16,337	tons acid/ yr	$23	per ton of acid	NA	NA	$368,865
Storage	10%	tank cost			NA	NA	$18,824
Transportation	783	loads/ yr	$903	per load	NA	NA	$707,230
Total Direct Costs					$4,685,599	$1,801,289	$3,733,318
Indirect Annual Costs							
Overhead	60%	total labor and material costs			$2,650,528	$1,023,865	$914,983
Administrative charges	2%	total capital investment			$106,878	$114,188	$829,873
Insurance	1%	total capital investment			$53,439	$57,094	$414,937
Capital Recovery	0.1627	based on 10 year life at 10%			$869,450	$928,920	$6,751,020
Process Safety Management/Risk Management Program					NA	NA	$150,000
Total Indirect Costs					$3,680,295	$2,124,068	$9,060,812
Total Annual Cost, $/yr					$8,365,894	$3,925,357	$12,794,131
SO2 Emissions, Pre-Control, tons/yr	9086.8	based on maximum sulfur content used in feedstock analysis (3.6%)					
SO2 DRE					95%	95%	95%
Stream Time					95%	95%	95%
SO2 - Amount Controlled, tons/yr					8,201	8,201	8,201
Control Cost, $/ton					$1,020	$479	$1,560
Cost per pound of product							
Pounds of product	216,470,307	lb CB/year (@ 100% capacity)			$0.039	$0.018	$0.059
	Year	Capacity			Cost per pound of product		
	1	75%			$0.052	$0.024	$0.079
	2	80%			$0.048	$0.023	$0.074
	3	85%			$0.045	$0.021	$0.070
	4	90%			$0.043	$0.020	$0.066
	5	95%			$0.041	$0.019	$0.062

3.3.5.4.3 *Conclusions*

The only control techniques determined to be technically feasible were the limiting of feedstock sulfur content or the installation of the following add-on control devices:

- an adsorption process by Selective Adsorption Associates, Inc.,
- the DynaWave System using limestone or caustic scrubbing material by Monsanto-Envirochem, and
- the SNOX sulfur recovery/conversion process by Haldor Topsoe.

These add-on control devices could achieve at least 95% reduction in SO_2 (post combustion) and were determined to have reasonable reliability.

To evaluate the economic reasonableness, EPA guidance suggests consideration of two cost-effectiveness ratios. One is the cost per ton of pollutant controlled, and the other is the cost per unit of production. The cost per ton of pollutant is approximately $2,400 per ton of SO_2 controlled, based on the costs discussed in Section 3.3.5.4.2. The cost of sulfur controls on a production base ranges from 4% to 30% of the price of carbon black product. Margins on carbon black product are typically in the single digit range.

In conclusion, given the very limited availability and economic infeasibility of feedstock containing low sulfur content, an annual average limit of less than 3% sulfur are not economically feasible. However, an annual 3% sulfur limit on CBO feedstock could be managed, and such a limit is consistent with recent BACT determinations made by LDEQ for other carbon black plants. Based on this assessment all emission calculations presented in this application are based on an annual average CBO sulfur limit of 3.0% and a short-term maximum concentration of 3.2%.

Rhodia

Baton Rouge Plant

June 14, 2007

Certified Mail Return Receipt Requested (7003 1010 0005 5151 9464)

Dr. Chuck Carr Brown, Assistant Secretary
Office of Environmental Services
Louisiana Department of Environmental Quality
P.O. Box 4314
Baton Rouge, LA 70821-4314

RE: Summary of CALPUFF BART Screening Modeling Analysis for
Rhodia Sulfuric Acid Plant

Dear Dr. Brown::

Providence Engineering & Environmental Group LLC (Providence) has completed a CALPUFF screening modeling analysis for the Rhodia Sulfuric Acid plant located in Baton Rouge, Louisiana for purposes of recently promulgated regulations associated with Best Available Retrofit Technology (BART). This letter summarizes the results of the base case scenario and an abated scenario. This base case scenario is formulated using the emission data and stack parameters provided by Rhodia. The abated scenario is formulated using estimated emission data and stack parameters from Rhodia's proposal to use caustic scrubbing to reduce SO_2 emissions by 94%.

BACKGROUND

The 1990 Clean Air Act Amendments required the United States Environmental Protection Agency (USEPA) to promulgate regulations to protect against visibility impairment (regional haze) in 156 scenic areas (also referred to as Class I areas) across the United States. Regional haze regulations in 40 CFR 51.300 through 51.309 and guidelines found in Appendix Y to 40 CFR Part 51, help states identify sources that are BART eligible and determine the level of control that represents BART. Based on the Regional Haze rule, various state agencies are in the process of performing screening analyses to determine a list of potential sources that may cause visibility impairment at Class I areas. These screening analyses have been performed using screening models or emissions and distance thresholds. It is expected that the sources that are not screened out by the state agencies will be required to either perform comprehensive long-range transport modeling using the USEPA-promulgated CALPUFF model (in a screening analysis or a refined analysis) and/or submit an engineering analysis.

The Louisiana Department of Environmental Quality (LDEQ) has established screening criteria. Facilities that could not reasonably be eliminated from BART consideration by the criteria are asked to perform site-specific CALPUFF modeling analyses to evaluate if they impact Breton and Caney Creek Class 1 areas by 0.5 deciviews or more. Rhodia has received a request from the LDEQ to perform the modeling analysis. Rhodia has requested that Providence perform a screening analysis for their Baton Rouge sulfuric acid plant. This report provides the summary for the screening analysis.

MODEL SETUP

A CALPUFF model is set up for the Rhodia sulfuric acid plant in accordance with the Central Regional Air Planning Association (CENRAP) protocol and the LDEQ protocol for BART analyses. This section summarizes the model setup for the CALPUFF screening analysis.

Site Location, Receptor Location And Model Range

The modeling domain is shown in the Lambert Conformal Conic (LCC) coordinate system in Figure 1. The grid cell size used in the models is 6 km. All the domain range, coordinate system, and spatial resolution are same to the south meteorological domain prepared by CENRAP. The blue crosses indicate the receptors at Breton Wilderness Area and Caney Creek Wilderness, and the red circle represents the Rhodia sulfuric acid facility. Figure 2 shows a more detailed map of the receptor and sources.

Figure 1 – Rhodia facility on Whole LCC Modeling Domain

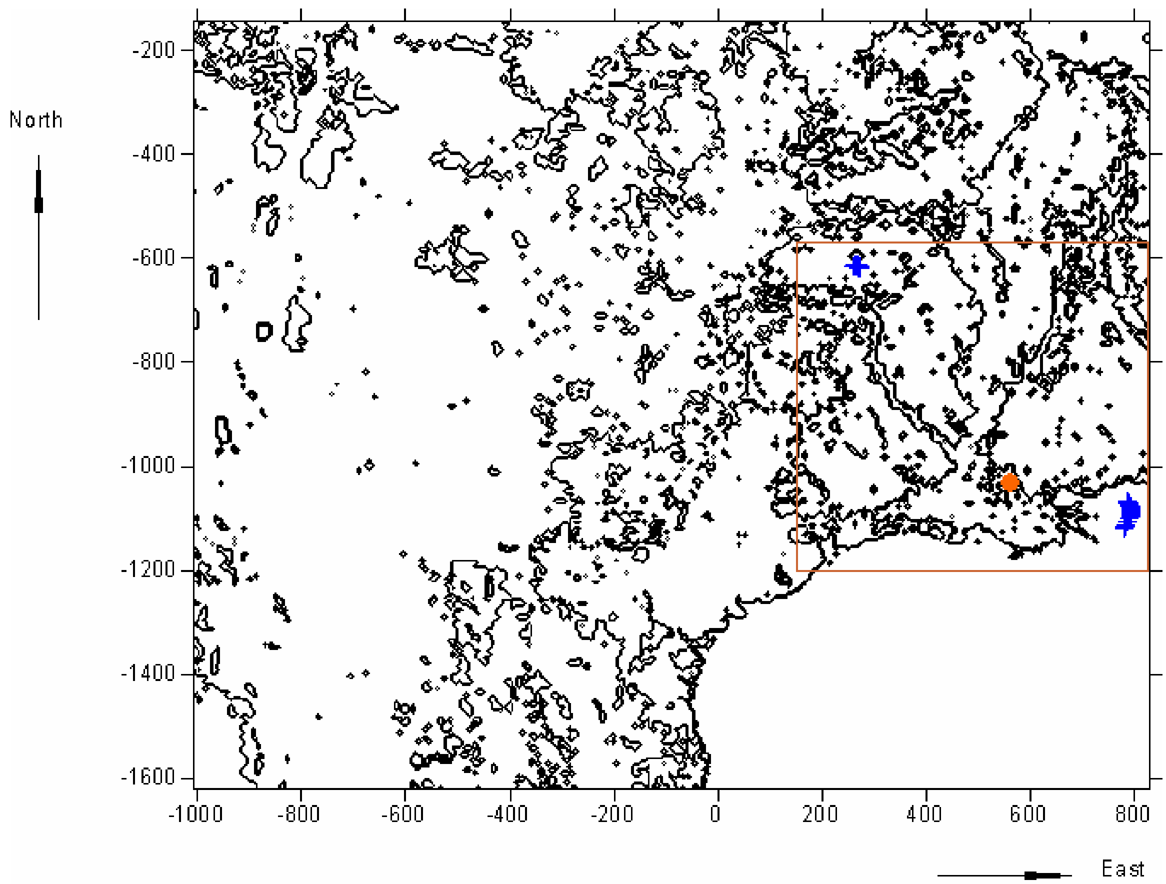
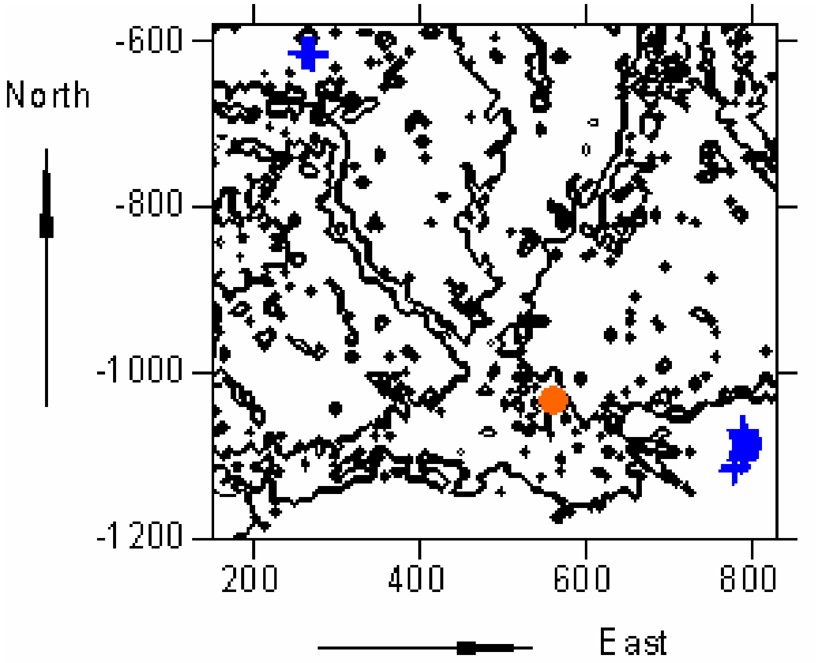


Figure 2 – Rhodia facility and Class I Areas



Meteorological data

The CALPUFF-ready meteorological data prepared by CENRAP is used directly for this screening analysis.

Emission rates and stack parameters

The emission rate and stack parameters used for the base case scenario and the abated scenario are provided in Table 1 below. A site elevation of 15.2 meters is used in the model.

Table 1 - Emission Rate and Stack Parameters

	Package Boiler	Base Case Sulfuric Acid Unit 2	Base Case Sulfuric Acid Unit 1	Abated Sulfuric Acid Unit 2	Abated Sulfuric Acid Unit 1
LCC Easting (km)	560.646	560.809	560.521	560.809	560.521
LCC Northing (km)	-1032.650	-1032.578	-1032.629	-1032.578	-1032.629
Stack Height (m)	18.288	76.2	76.2	39.0	39.0
Exit temperature (K)	517.04	338.71	335.37	305.4	305.4
Exit Velocity (m/s)	23.04	8.11	10.42	35.475	34.377
Diameter (m)	1.07	3.05	1.83	1.37	0.91
SO2 24 h max emission (g/s)	0.03	244.18	113.90	29.93	14.18
NOx 24 h max emission (g/s)	3.07	13.38	6.20	13.38	6.20
PM10 24 h max emission (g/s)	0.16	0.09	0.05	0.09	0.05

Model options

The model is set up following CENRAP's guidance on CALPUFF screening modeling. Key model options are listed below:

CALPUFF:
Dispersion: Pasquill-Gifford (PG) coefficient.
Chemical species modeled include: SO_2, SO_4, NO_x, HNO_3, NO_3, PM.

Chemistry: Mesopuff.
Aqueous phase chemistry: Use relative humidity (RH) instead of real water content.
Ozone: Ozone data is provided by LDEQ.
Ammonia: Constant ammonia concentration is assumed as 3 ppb.
Wet and dry deposition: Both gaseous and particle phase are modeled.

POSTUTIL:
Species input: SO_2, SO_4, NO_x, HNO_3, NO_3, PM.
Species output: SO_2, SO_4, NO_x, HNO_3, NO_3, PM.
Background NH_3: 3 ppb.

CALPOST:
Visibility is calculated using Mehtod 6 based on IMPROVE's equation:

$$b_{ext}=3f(RH)[(NH_4)_2SO_4]+3f(RH)[NH_4NO_3]+ 10[PM] + b_{Ray}$$

where b_{ext} is the calculated light extinction, f(RH) is the humidity effect, b_{Ray} is the Rayleigh scattering of air. A light extinction efficiency of 10 is used for PM.
The change of haze index in deciviews is calculated by:

$$\Delta dv = 10 \ln (\{b_{background}+ b_{source}\}/ b_{background})$$

where b_{source} is the light extinction caused by the source and the $b_{background}$ is the natural background light extinction.

The natural background light extinction is provided in CENRAP's guidance. For eastern states, background extinctions are EC=0.02, SO_4=0.23, NO_3=0.1, PMC=3, SOC=1.4, Soil=0.5, Raleight scattering=10.

Monthly f(RH) values at Breton and Caney Creek are obtained from EPA's Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule. As suggested in LDEQ's model protocol, the RH factors at the centroid receptor of each Class I area are used for the 12 months.

Recompilation

The CALPUFF, CALPOST and POSTUTIL programs were recompiled with the FORTRAN source code provided in the CALPUFF BART version. The compiler used is Lahey/Fujitsu Fortran Express v7.1. The changes for the recompilation are described below:

CALPUFF: In params.puf, mxnx=320,mxny=265, mxoz=2725. The source code is in calpuff.for and the executable file is calpuffc.exe.

POSTUTIL

In params.utl, PARAMETER(mxgx=320), PARAMETER(mxgy=265). The source code is in postutilc.for and the executable file is postutilc.exe

CALPOST
In params.pst, PARAMETER(mxgx=320) , PARAMETER(mxgy=265) . The source code is in the calpost.for. The executable file is calpost.exe.

To recompile, the parameters in the parameter files are changed first as indicated in the above paragraphs. The source files are recompiled by Lahey's command. The newly generated .exe files are used for the model runs in this work.

MODEL RESULTS

This section describes the modeling results for the CALPUFF screening analysis of the base case scenario and the abated scenario.

Model runs

For 2001, 36 met files are used in three groups of CALPUFF and POSTUTIL runs. The results are then merged by APPEND, a tool of CALPUFF BART version. For 2002 and 2003, 12 met files of each year are directly used in CALPUFF and POSTUTIL.

Model results of 2001, 2002, 2003

Modeling runs were executed for 2001, 2002, and 2003. Based on these runs, the tables below provide the results for the respective years under the base case scenario and the abated scenario. CALPOST was run separately for Breton and Caney Creek receptors since different RH factors were used for the two Class I areas.

Table 2 - CALPUFF Screening Analysis Results for Rhodia Base Case Scenario

2001 Breton Base Case Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2001	191	5	2.003	4.3	99.53	0.44	0.02	1
2001	229	40	1.822	4.3	99.62	0.37	0.01	2
2001	231	40	1.315	4.3	99.72	0.26	0.02	3
2001	192	40	1.275	4.3	99.36	0.6	0.03	4
2001	202	40	1.18	4.3	99.67	0.31	0.02	5
2001	163	1	1.162	4	99.5	0.49	0.02	6
2001	190	1	1.102	4.3	99.27	0.7	0.03	7
2001	89	40	1.043	3.7	94.16	5.81	0.02	8
2001	226	1	1.034	4.3	99.77	0.22	0.02	9
2001	260	40	1.023	4.2	99.72	0.26	0.02	10
2001	53	40	0.962	3.5	93.9	6.07	0.03	11
2001	90	1	0.911	3.7	98.05	1.93	0.02	12
2001	230	40	0.897	4.3	99.16	0.81	0.02	13
2001	91	1	0.851	3.604	97.69	2.29	0.02	14
2001	187	40	0.747	4.3	99.79	0.19	0.01	15
2001	261	40	0.721	4.2	99.79	0.2	0.01	16
2001	212	40	0.571	4.3	99.8	0.18	0.02	17
2001	225	40	0.515	4.3	99.42	0.56	0.02	18
2001	232	1	0.508	4.3	99.72	0.26	0.02	19
2001	162	16	0.489	4	99.73	0.25	0.01	20

2001 Caney Creek Base Case Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2001	44	43	0.726	3.1	94.33	5.65	0.02	1
2001	186	58	0.549	3.4	99.92	0.07	0.01	2
2001	350	58	0.477	3.5	91.36	8.61	0.03	3
2001	207	58	0.472	3.4	99.69	0.3	0.01	4
2001	235	49	0.472	3.4	99.77	0.22	0.01	5
2001	178	107	0.441	3.6	99.66	0.33	0.01	6
2001	318	76	0.431	3.4	94.29	5.68	0.03	7
2001	14	49	0.408	3.4	93.66	6.32	0.02	8
2001	295	75	0.379	3.5	97.72	2.26	0.02	9
2001	187	75	0.369	3.4	99.95	0.05	0.01	10

2002 Breton Base Case Scenario

YEAR	DAY	RECEPTOR	DELTA	F(RH)	%_SO4	%_NO3	%_PMF	Rank

			DV					
2002	194	40	1.389	4.3	99.79	0.2	0.01	1
2002	206	40	1.075	4.3	99.8	0.19	0.01	2
2002	203	40	1.048	4.3	99.91	0.08	0.01	3
2002	186	1	0.989	4.3	99.88	0.11	0.01	4
2002	238	1	0.917	4.3	99.8	0.19	0.01	5
2002	213	40	0.844	4.3	99.74	0.24	0.02	6
2002	237	40	0.787	4.3	99.76	0.22	0.02	7
2002	204	1	0.691	4.3	99.92	0.07	0.01	8
2002	334	1	0.656	3.7	96.62	3.35	0.02	9
2002	202	40	0.578	4.3	99.9	0.09	0.01	10
2002	325	1	0.555	3.7	95.67	4.31	0.02	11
2002	363	40	0.533	3.7	95.51	4.47	0.02	12
2002	25	1	0.522	3.7	94.62	5.36	0.02	13
2002	299	40	0.51	3.7	97.19	2.79	0.01	14
2002	258	40	0.488	4.2	99.42	0.56	0.02	15

2002 Caney Creek Base Case Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2002	234	76	1.102	3.4	99.6	0.39	0.01	1
2002	177	43	0.903	3.6	98.86	1.13	0.01	2
2002	222	76	0.82	3.4	99.45	0.53	0.02	3
2002	103	75	0.81	3	99.35	0.63	0.01	4
2002	298	43	0.772	3.5	97.13	2.86	0.01	5
2002	302	43	0.772	3.5	97.94	2.06	0.01	6
2002	23	75	0.63	3.4	94.87	5.11	0.02	7
2002	178	75	0.624	3.6	99.3	0.69	0.01	8
2002	22	41	0.544	3.4	93.24	6.73	0.02	9
2002	301	58	0.478	3.5	98.02	1.97	0.01	10

2003 Breton Base Case Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2003	74	40	1.626	3.7	96.17	3.82	0.01	1
2003	310	1	1.486	3.7	99.22	0.75	0.03	2
2003	199	40	1.241	4.3	99.91	0.08	0.01	3
2003	75	40	0.987	3.7	96.42	3.57	0.01	4
2003	364	9	0.979	3.7	95.98	4	0.02	5
2003	22	1	0.851	3.7	92.7	7.28	0.03	6
2003	295	1	0.755	3.7	98.91	1.01	0.08	7
2003	81	16	0.713	3.7	97.89	2.07	0.03	8
2003	220	1	0.647	4.3	99.81	0.18	0.02	9
2003	160	1	0.643	4	99.8	0.19	0.01	10
2003	77	1	0.636	3.7	95.84	4.14	0.02	11
2003	32	40	0.59	3.508	96.35	3.63	0.01	12
2003	339	1	0.57	3.7	96.86	3.13	0.02	13
2003	147	40	0.567	3.8	99.57	0.41	0.01	14
2003	103	1	0.546	3.6	97.72	2.25	0.03	15
2003	132	40	0.537	3.8	98.79	1.19	0.02	16
2003	41	40	0.522	3.5	94.82	5.16	0.02	17
2003	161	40	0.501	4	99.8	0.19	0.01	18
2003	202	40	0.477	4.3	99.63	0.35	0.02	19

2003 Caney Creek Base Case Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2003	281	41	1.219	3.5	98.4	1.59	0.01	1
2003	76	43	1.137	2.9	96.81	3.17	0.02	2
2003	52	43	1.097	3.1	95.85	4.14	0.01	3
2003	283	107	1.092	3.5	98.37	1.61	0.01	4
2003	284	41	0.978	3.5	98.79	1.2	0.01	5
2003	282	119	0.858	3.5	98.08	1.91	0.01	6
2003	29	58	0.742	3.4	95.75	4.24	0.01	7
2003	227	107	0.696	3.4	99.7	0.29	0.01	8
2003	242	43	0.587	3.4	99.03	0.96	0.02	9
2003	228	119	0.581	3.4	99.92	0.07	0.01	10
2003	71	49	0.536	2.9	98.38	1.61	0.01	11
2003	285	41	0.515	3.5	99.67	0.32	0.01	12
2003	239	58	0.481	3.4	99.86	0.13	0.01	13

Table 3 - CALPUFF Screening Analysis Results for Rhodia Abated Scenario

2001 Breton Abated Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2001	191	5	0.288	4.3	97.05	2.79	0.17	1
2001	229	40	0.207	4.3	97.08	2.8	0.12	2
2001	231	40	0.2	4.3	97.73	2.14	0.14	3
2001	53	39	0.184	3.5	66.47	33.34	0.19	4
2001	89	40	0.171	3.7	66.95	32.92	0.13	5
2001	192	40	0.164	4.3	96	3.73	0.27	6
2001	163	1	0.148	4	95.73	4.14	0.13	7
2001	190	1	0.147	4.3	94.38	5.39	0.23	8
2001	226	1	0.134	4.3	98.05	1.82	0.13	9
2001	260	40	0.134	4.2	97.74	2.13	0.13	10

2001 Caney Creek Abated Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2001	44	43	0.13	3.1	67.15	32.74	0.11	1
2001	350	58	0.092	3.5	56.9	42.95	0.14	2
2001	14	49	0.074	3.4	64.33	35.57	0.1	3
2001	318	76	0.072	3.4	66.86	32.97	0.16	4
2001	186	58	0.07	3.4	99.36	0.56	0.07	5
2001	207	58	0.059	3.4	97.56	2.36	0.09	6
2001	235	49	0.059	3.4	98.12	1.78	0.1	7
2001	338	75	0.055	3.5	69.11	30.68	0.21	8
2001	45	75	0.054	3.1	70.84	29.05	0.11	9
2001	295	75	0.053	3.5	83.73	16.11	0.16	10

2002 Breton Abated Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2002	194	40	0.17	4.3	98.18	1.73	0.09	1
2002	206	40	0.14	4.3	98.28	1.65	0.07	2
2002	203	40	0.12	4.3	99.24	0.67	0.1	3
2002	238	1	0.116	4.3	98.47	1.42	0.11	4
2002	186	1	0.108	4.3	98.93	0.96	0.1	5
2002	237	40	0.096	4.3	98.18	1.68	0.13	6
2002	25	1	0.088	3.7	68.15	31.73	0.12	7
2002	72	1	0.086	3.7	71.27	28.63	0.1	8
2002	363	40	0.086	3.7	72.09	27.78	0.13	9
2002	325	1	0.079	3.7	70.75	29.13	0.13	10

2002 Caney Creek Abated Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2002	234	76	0.144	3.4	96.64	3.28	0.08	1
2002	177	43	0.12	3.6	91.22	8.71	0.08	2
2002	298	43	0.113	3.5	80.17	19.76	0.07	3
2002	302	43	0.109	3.5	85.53	14.41	0.06	4
2002	22	41	0.107	3.4	63.98	35.89	0.12	5
2002	103	75	0.106	3	94.88	5.02	0.1	6
2002	222	76	0.101	3.4	95.28	4.58	0.14	7
2002	23	75	0.09	3.4	69.18	30.72	0.1	8
2002	178	75	0.078	3.6	94.55	5.38	0.07	9
2002	5	41	0.069	3.4	50.37	49.5	0.13	10

2003 Breton Abated Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2003	74	40	0.286	3.7	75.56	24.36	0.08	1
2003	310	4	0.201	3.7	93.06	6.7	0.25	2
2003	199	40	0.166	4.3	99.22	0.69	0.09	3
2003	364	9	0.161	3.7	74.63	25.26	0.11	4
2003	75	40	0.16	3.7	76.76	23.17	0.07	5
2003	32	40	0.107	3.508	76.67	23.24	0.09	6
2003	81	17	0.106	3.7	84.86	14.91	0.23	7
2003	77	1	0.104	3.7	73.75	26.11	0.13	8
2003	295	1	0.1	3.7	92.06	7.32	0.62	9
2003	22	1	0.093	3.7	56.9	42.91	0.19	10

2003 Caney Creek Abated Scenario

YEAR	DAY	RECEPTOR	DELTA DV	F(RH)	%_SO4	%_NO3	%_PMF	Rank
2003	52	43	0.173	3.1	74.09	25.82	0.09	1
2003	76	43	0.165	2.9	79.22	20.65	0.13	2
2003	281	41	0.163	3.5	88.29	11.62	0.09	3
2003	283	118	0.147	3.5	87.85	12.07	0.08	4
2003	284	58	0.13	3.5	90.72	9.2	0.08	5
2003	29	76	0.122	3.4	73.59	26.34	0.07	6
2003	282	119	0.116	3.5	86.23	13.68	0.09	7
2003	227	92	0.092	3.4	97.55	2.37	0.07	8
2003	242	43	0.08	3.4	92.55	7.32	0.13	9
2003	71	49	0.074	2.9	88.14	11.77	0.09	10

Sources with modeled maximum impacts below the 0.5 deciview threshold are exempt from the remainder of the BART process. As shown in the tables above, the visibility impacts from the base case scenario exceed the 0.5 deciview threshold for several days each year. In the abated scenario, impacts from the sources at the Rhodia facility do not exceed the 0.5 deciview threshold.

If you have any questions please call me at (225) 359-3768.

Sincerely,

John D. Richardson
Environmental Manager

cc: Yousheng Zeng, Ph D., P.E., Providence - Certified Mail Return Receipt Requested (7003 1010 0005 5151 9297)
Tim Allen, U.S. Fish and Wildlife Service- Certified Mail Return Receipt Requested (7003 1010 0005 5151 9280)
Eric Snyder, EPA Region VI - Certified Mail Return Receipt Requested (7003 1010 0005 5151 9273)

File 404.1.8

Rhodia

Baton Rouge Plant

June 14, 2007

Certified Mail Return Receipt Requested (7003 1010 0005 5151 9464)

Dr. Chuck Carr Brown, Assistant Secretary
Office of Environmental Services
Louisiana Department of Environmental Quality
P.O. Box 4314
Baton Rouge, LA 70821-4314

RE: BART Engineering Analysis for Rhodia Sulfuric Acid Plant

Dear Dr. Brown:

In 1999, EPA promulgated regulations to improve visibility in 156 national parks and wilderness areas (known as Class I Areas) across the country. The regulations are referred to as the Regional Haze rule. These regulations, included in 40 CFR 51 Subpart P, direct states to revise their State Implementation Plan (SIP) to address Class I area visibility. A major component of the regional haze program is Best Available Retrofit Technology (BART), which requires emission controls for existing stationary sources[1]. The pollutants to which BART applies are fine particulate matter (PM2.5) that cause light scattering, and compounds that contribute to PM2.5 formation, such as nitrogen oxides, sulfur dioxides, certain volatile organic compounds, and ammonia.

Once a state determines that a facility is BART-eligible, an air quality modeling analysis (such as CALPUFF) is performed. Screening and refined modeling are conducted to determine whether the facility is contributing to visibility impairment in a Class I Area; if so, the facility must then implement BART.

BART is established on a case-by-case basis, taking into consideration the technology available. Once technically infeasible options are eliminated, the facility may then consider

- the costs of compliance,
- the energy and non-air quality environmental impacts of compliance,
- any pollution control equipment in use or in existence at the source,
- the remaining useful life of the source, and
- the degree of improvement in visibility which may reasonably be anticipated

to select a best alternative which will represent BART.

The Rhodia Process and BART Eligibility

[1] An existing stationary source is defined as one that is (1) located at one of 26 specific types of facilities listed in 40 CFR 51.301, (2) began operation after August 7, 1962 and was in existence on August 7, 1977, and (3) has potential emissions of 250 tons per year or more for any visibility-impairing pollutant.

Rhodia Inc., P.O. Box 828, Baton Rouge, LA 70821

Baton Rouge Plant

The Rhodia Baton Rouge Sulfuric Acid Plant produces sulfuric acid by using two sulfuric acid production trains, Unit No.1 and Unit No. 2. Unit No.1 was constructed in 1953, and is a 700 ton/day unit. Unit No. 2 was constructed in 1968, and is a 1500 ton/day unit. Rhodia receives spent sulfuric acid and hazardous waste fuels from off-site sources and recovers the sulfur and energy values in its industrial furnaces, forming fresh sulfuric acid.

In March 2007, the state of Louisiana identified Rhodia as a BART-eligible source and requested that it assess its contribution to regional haze. Rhodia performed a CALPUFF screening analysis, assessing impacts in the nearby Class I areas of Breton Wilderness and Caney Creek Wilderness. The following emission rates and stack parameters were used:

Table 1 – Current Emission Rates and Stack Parameters

	Sulfuric Acid Unit No. 2	Sulfuric Acid Unit No. 1	Package Boiler
LCC Easting (km)	560.809	560.521	560.646
LCC Northing (km)	-1032.578	-1032.629	-1032.650
Stack Height (m)	76.2	76.2	18.288
Exit temperature (K)	338.71	335.37	517.04
Exit Velocity (m/s)	8.11	10.42	23.04
Diameter (m)	3.05	1.83	1.07
SO_2 24 h max emission (g/s)	244.18	113.90	0.03
NO_x 24 h max emission (g/s)	13.38	6.20	3.07
PM10 24 h max emission (g/s)	0.09	0.05	0.16

Complete information on the modeling inputs, setup, and results are provided in the accompanying letter report dated June 14, 2007.

The screening modeling results indicate that the Rhodia facility does impact visibility in both the Breton and Caney Creek areas. Rhodia may choose to conduct a refined modeling analysis to confirm the impact; however, Rhodia has recently entered into a consent decree with USEPA to reduce SO_2 emissions. Therefore, it is more expeditious for Rhodia to forego the refined analysis, and proceed with an emissions abatement strategy which will satisfy both the consent decree and BART.

Analysis of Available Control Technologies

Rhodia has considered the following SO_2 control technologies that may potentially be applicable to these units:

Alkali Scrubbing. The alkali scrubbing process uses ammonia (NH_3), caustic (sodium hydroxide, NaOH), or soda ash (sodium carbonate, Na_2CO_3) to remove inorganic sulfur compounds from the sulfuric acid unit tail gas. The system removes the compounds as chemically fixed salts. This technology has been used successfully at several U.S. plants.

Amine Processes (ASARCO, UCAP, and Cansolv). Removal of SO_2 by amines has been used since the 1960's. The amine absorbs the acidic components (SO_2, sulfur trioxide, sulfuric acid mist, and carbon dioxide) from the gas. Amines differ in their selectivity for SO_2 over carbon dioxide, SO_2 loading, amount of steam required for regeneration, and the amount of amine degradation in the regeneration system. Problems with amine systems include degradation from heat in the regeneration process, degradation from sulfur trioxide and sulfuric acid (vapor, particles, and mist), corrosion of materials and equipment, high steam usage, and high capital costs. Amine processes are suitable applications in petroleum refining processes. There are no amine-based systems treating sulfuric acid plant tail gas in the Unites States.

Add-On Double Absorption Process. Conversion to integral double absorption requires access to the existing converter, or the addition of a second converter with one catalyst bed, and plot space near the existing converter area. In a few plants, the existing plant design makes conversion to integral double absorption difficult, expensive and/or not possible. In some rare cases, the conversion to double absorption equipment can be installed remote to the existing converter area. The double absorption process can be either fuel fired or not. The double absorption system includes an absorption tower system (tower, pump tank, acid cooler, and mist eliminator); a fuel-fired system also includes fuel-fired indirect gas heater with gas heat exchanger, a process gas heat exchanger, and a final converter stage before the absorption tower. The additional capital costs and higher operating cost for heater fuel has limited use of the fuel-fired process to a few special cases.

Of the alternatives listed above, amine processes are suitable for petroleum refining processes, not for the processes at the Rhodia facility.

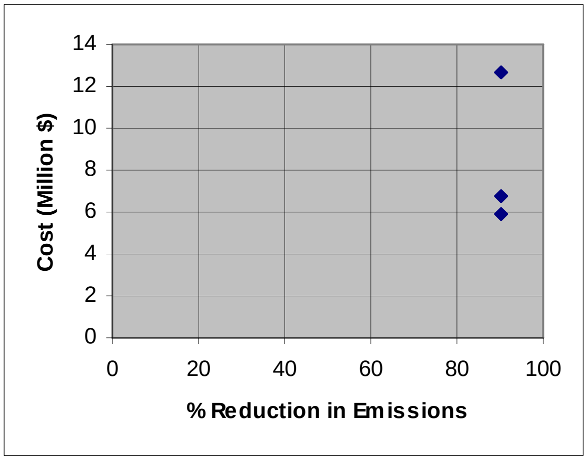
Double absorption is difficult to implement as a retrofit technology due to space constraints in the units; the physical positioning of equipment at Rhodia is such that the necessary equipment cannot easily be installed. The capital cost for double absorption for the No. 2 Unit is approximately $12.63 million.

For ammonia scrubbing, the non-air quality environmental impacts make this option prohibitive. First, ammonia storage is hazardous and undesirable. Second, the effluent cannot be disposed of due to bio-toxicity; therefore, it would have to be sold (a business undertaking the facility is not currently positioned for) or burned (requiring extra fuel and diminishing plant capacity). Third, there will be emissions of residual ammonia, a toxic air pollutant. The capital cost for ammonia scrubbing is approximately $6.73 million.

Caustic scrubbing is technically feasible and can achieve a high SO_2 control efficiency. Also, the non-air quality environmental impacts are much more favorable: first, the sodium is used twice—once for scrubbing, then again for neutralization of weak acid effluent. Second, the sodium sulfate effluent is considered safe for discharge. The capital cost for caustic scrubbing is approximately $5.94 million.

All three of these technologies (double absorption, ammonia scrubbing, and caustic scrubbing) have similar destruction efficiencies (approximately 94%), but the costs are notably dissimilar. A least-cost envelope for the three options is presented as Figure 1; however, it is obvious an incremental cost analysis is not necessary since destruction efficiencies do not vary.

Figure 1 -- Least-Cost Envelope



Selection of Proposed Technology

Based on these considerations, Rhodia proposes to use caustic scrubbing to reduce SO_2 emissions. The scrubbing will reduce emissions by ≥94% which corresponds to long-term (annual average) emission limits of 1.9 pounds of SO_2 emitted per ton of sulfuric acid produced (lb/ton) for Unit 1 and 2.2 lbs/ton for Unit 2. The short-term (3-hour average) limits for both units will be set at 3.0 lbs/ton. This compares favorably to other emission standards available, specifically:

- 40 CFR 60, Subpart H—this New Source Performance Standard limits emissions to 4 lb/ton.

- RACT/BACT/LAER Clearinghouse (RBLC)--A search of all permitted control technologies within the last 10 years for sulfuric acid plants yielded the following results:

  - 3.5 lb/ton (double absorption scrubber, Farmland Hydro, L.P., Florida)
  - 4.0 lb/ton (dual absorption catalyst, PCS Phosphate Company, North Carolina)
  - 4.0 lb/ton (Lucite, Texas)
  - 3.5 lb/ton (double absorption, Piney Point Phosphates, Florida)

The proposed control not only meets the best available retrofit technology, it surpasses the control for new facilities under NSPS and recently permitted new facilities.

Although not required by LDEQ, Rhodia has conducted CALPUFF screening modeling with the abated SO_2 emissions. The emission rates and stack parameters used are summarized in Table 2. Details of the modeling analysis are provided in the accompanying letter report.

Table 2 – Proposed Emission Rates and Stack Parameters

	Sulfuric Acid Unit No. 2	Sulfuric Acid Unit No. 1	Package Boiler
LCC Easting (km)	560.809	560.521	560.646
LCC Northing (km)	-1032.578	-1032.629	-1032.650
Stack Height (m)	39.0	39.0	18.288
Exit temperature (K)	305.4	305.4	517.04
Exit Velocity (m/s)	35.475	34.377	23.04
Diameter (m)	1.37	0.91	1.07
SO_2 24 h max emission (g/s)	29.93	14.18	0.03
NO_x 24 h max emission (g/s)	13.38	6.20	3.07
PM10 24 h max emission (g/s)	0.09	0.05	0.16

As demonstrated in the accompanying letter report, with the SO_2 abatement system, all impacts of the Rhodia facility to the Breton and the Caney Creek Wilderness Area are below 0.5 deciview.

Rhodia believes that this report demonstrates BART for its facility. Per proposed federal consent decree (D.J. Ref. 90-5-2-1-08500) to which LDEQ is a signatory, the facility will be operating under its abated scenario in mid-2012 for Unit 1, and early 2011 for Unit 2. These dates are well in advance of the expected deadline for BART controls.

Since Rhodia is already conducting preliminary engineering on the project, we would like your concurrence on our selection of the proposed technology and reduction efficiency at your earliest convenience. Please contact me at (225) 359-3768 with any questions or to schedule a meeting to discuss further.

Sincerely,

John D. Richardson
Environmental Manager

cc: Yousheng Zeng, Ph D., P.E., Providence - Certified Mail Return Receipt Requested (7003 1010 0005 5151 9297)
Tim Allen, U.S. Fish and Wildlife Service- Certified Mail Return Receipt Requested (7003 1010 0005 5151 9280)
Eric Snyder, EPA Region VI - Certified Mail Return Receipt Requested (7003 1010 0005 5151 9273)

File 404.1.8

ConocoPhillips LDEQ RECEIPT JUN 29 PM 4 21

ConocoPhillips Company
Alliance Refinery Agency Interest
No. 2418
P. O. Box 176
Belle Chasse, LA 70037
(504) 656-7711

June 28, 2007

RECEIVED JUN 29 2007 LDEQ

Dr. Chuck Carr Brown, Assistant Secretary
Office of Environmental Services
Louisiana Department of Environmental Quality
P.O. Box 4313
Baton Rouge, LA 70821-4313

HAND DELIVERED

RECEIVED JUL 03 2007 LDEQ/OEA/AD Engineering Support

RE: ConocoPhillips Company – Alliance Refinery, AI# 2418
BART Engineering Analysis and Modeling Report

Dear Dr. Brown:

Pursuant to the requirements of 40 CFR 51.301 and in accordance with the discussions between Louisiana Department of Environmental Quality (LDEQ) and ConocoPhillips Company-Alliance Refinery (ConocoPhillips) in the May 11, 2007 meeting, ConocoPhillips is submitting the referenced report for review. Additionally, ConocoPhillips has combined both the refined modeling results report and the required BART Engineering Analysis into one submittal per LDEQ's request. This submittal has been revised to incorporate the changes requested by LDEQ from the agency's review of the draft document submitted for review to LDEQ on May 29, 2007.

On July 1, 1999, EPA promulgated rules to address visibility impairment, or regional haze, at national parks and wilderness areas designated as federal Class I areas. Guidelines issued by the EPA in July 2005 provided direction to the states for implementing the Regional Haze rules. Affected states, including Louisiana, are required to develop plans for addressing visibility impairment. The regulation specifies that any BART-eligible source that had not been screened out by the LDEQ must perform refined modeling. The Alliance Refinery received notice from LDEQ on January 23, 2007, that the refinery had not passed the BART screening modeling process and would be subject to performing refined modeling.

The Alliance Refinery performed refined modeling for the years 2001-2003, as required by Central Regional Air Planning Association (CENRAP) guidance. The result of the refined modeling was a measure of visibility conditions at the Breton Wilderness Class I area. The 98th percentile modeled value was compared to the natural visibility conditions for the area. The modeling performed for Alliance Refinery resulted in a difference between the modeled and natural visibility of greater than 0.5 deciviews (dv). This difference of greater than 0.5 dv, indicates the Alliance Refinery is a contributor to visibility impairment at the Breton Wilderness Class I area. Refined modeling was performed for individual BART-eligible sources to evaluate the contribution of each source to the visibility impairment. The culpability analysis allowed separating emission sources subject to BART engineering analysis from sources that do not significantly contribute to visibility impairment. The emission sources subject to BART engineering analysis are the Fluidized Catalytic Cracker and the Process Refinery Flares. However, LDEQ has also requested that the Alliance Refinery include the Crude Unit Heater in the analysis.

Facilities with BART sources are directed to make a determination in accordance with 40 CFR 51, Appendix Y. They are also required to include information documenting the projected hourly and annual emission limits for the selected BART control strategies. The refinery believes the attached information meets the above requirements.

On December 5, 2005 ConocoPhillips and the EPA entered into a Consent Decree (Civil Action No. H-05-0285). The BART engineering analysis utilized emission reductions that are mandated per the Consent Decree for the Fluidized Catalytic Cracker, the Process Refinery Flares and the Crude Unit Heater. Implementing these control projects per the Consent Decree emissions reductions will result in reducing the overall site visibility impacts for the eighth highest delta dv from the baseline case ranging from 2.34 dv to 3.61 to 1.30 to 1.66 dv. Additionally, the Consent Decree created many other federally enforceable emission reductions for NO_x, SO_2 and PM that have either been implemented since 2003 or will be implemented in the future, thus significantly reducing the refinery's impact on the Breton Wilderness Class I area.

If you, or your staff, have any questions concerning this submittal, please call Steve Johnson of my staff at (504) 656-3669.

Sincerely,

Laurence R Poché

Laurence R. Poché
Environmental Service Superintendent

Attachments
LRP/swj

A10-07

cc: Kelly J. Bradberry – Sage Environmental Consulting
John Dyer – LDEQ Permits
James Orgeron – LDEQ Engineering

SAGE
ENVIRONMENTAL CONSULTING

BART Engineering Analysis For

ConocoPhillips

Alliance Refinery (AI No. 2418)

Prepared by:

SAGE
ENVIRONMENTAL CONSULTING

Reviewed by:

Laurence R. Poché
Kelly Jean Bradberry

June 2007

8440 JEFFERSON HIGHWAY, SUITE 400 • BATON ROUGE, LOUISIANA 70809 • 225/927-2258 • FAX 225/927-2256

ConocoPhillips Company
BART Engineering Analysis
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1.0 Introduction

1.1 Objectives

The Regional Haze Rule regulations require Best Available Retrofit Technology (BART) for any BART-eligible source that "emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility" in any mandatory Class I federal area. Louisiana Department of Environmental Quality (LDEQ) has identified the Alliance Refinery, located near Belle Chasse, Louisiana, owned and operated by ConocoPhillips Company (ConocoPhillips), as being a source that is eligible for consideration of BART controls. The purpose of this document is to summarize the procedures used to conduct the modeling analysis to quantify the visibility impact of BART control options at the Alliance Refinery and the engineering analysis of the various control options for defining BART.

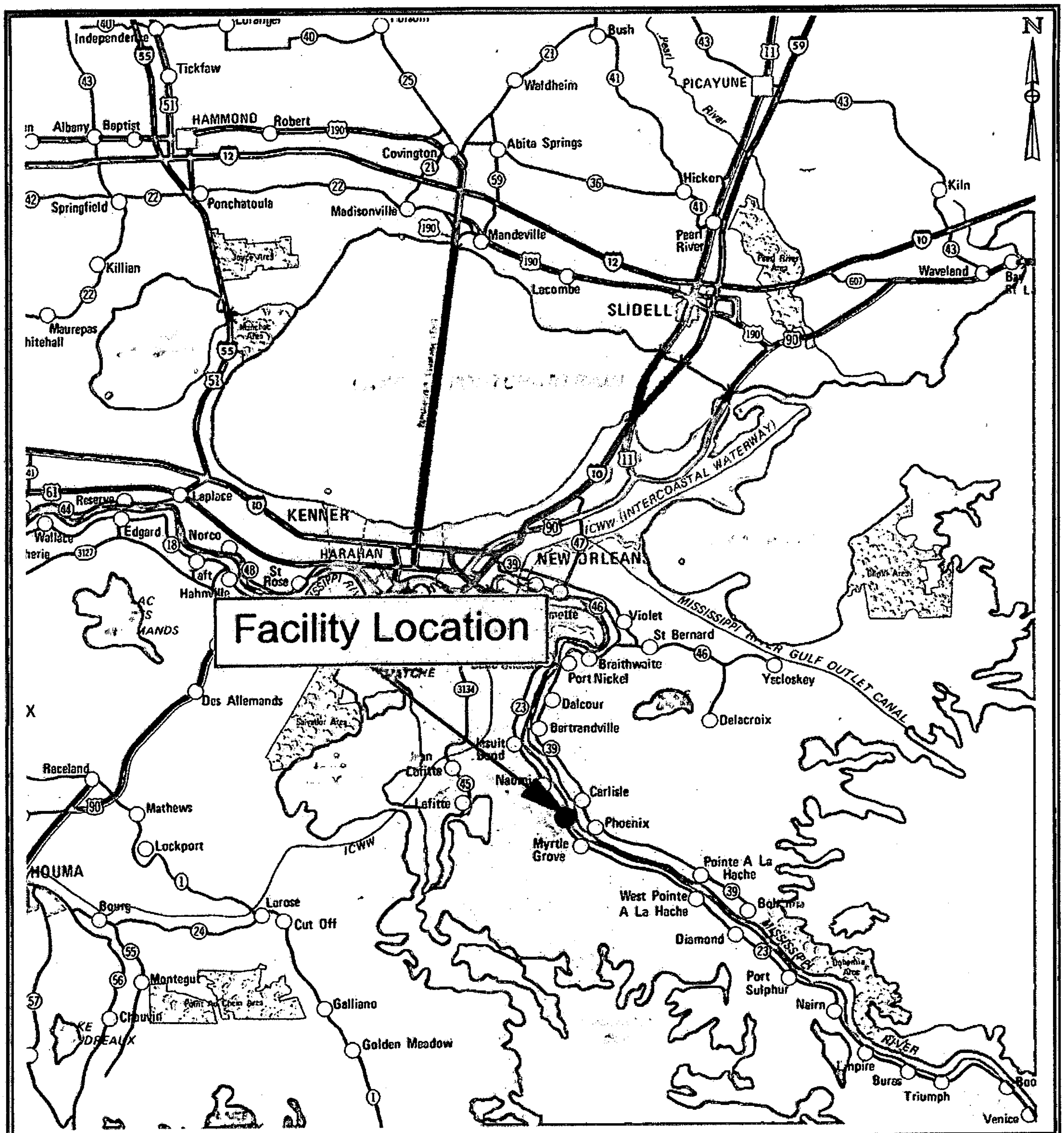
1.2 Organization of Document

Section 1.3 provides a brief background about the Alliance Refinery and a summary of the refined modeling results. The Modeling Report in Attachment I summarizes the procedures used to determine baseline actual emissions for the 2001 to 2003 period and presents the baseline emission rates. Additionally, the CALPUFF modeling procedures, the visibility results for the baseline modeling case and the plan for post controls are presented. BART determinations based on the costs and the improvements in visibility associated with each emission control project are presented in Section 2.0. Finally, in response to discussions with LDEQ on the draft report submitted on May 29, 2007, information on BART eligible sources that do not have planned controlled projects at this time due to the level of effectiveness on reducing the impact of visibility at the designated Class I area are included in Section 3.0.

1.3 Facility Information and Background Summary

The Alliance Refinery produces a wide range of petroleum products from crude oil, such as LPG, motor gasoline, jet fuel, diesel, carbon black feedstock, propane, and coke. The Alliance Refinery also produces petrochemicals such as benzene, toluene, xylenes, and by-product elemental sulfur. Emission sources at the Alliance Refinery include process heaters, boilers, storage vessels, loading facilities, fugitive emissions from equipment, process vents, and flares. A Facility Map Location and a Plot Plan are included in this submittal (see Figure 1-1 and 1-2, respectively).

As stated in the cover letter, the Alliance Refinery received notice from LDEQ on January 23, 2007, that the Alliance Refinery had not passed the BART screening modeling performed by LDEQ and the Alliance Refinery would be required to perform refined modeling. Attachment II is a copy of the written notification from LDEQ to the Alliance Refinery. The visibility impacts were evaluated for the Breton Wilderness Class I area, which is located approximately 94 kilometers from Belle Chasse, LA. The result of the modeling was a measure of visibility conditions at the Breton Wilderness Class I area with a difference greater than 0.5 deciview (dv); therefore, the Alliance Refinery is considered to contribute to the visibility impairment at the Breton Wilderness Class I area and is required to perform an engineering analysis.



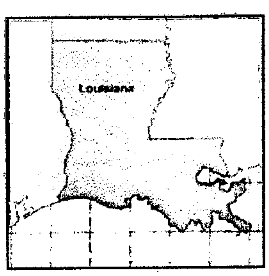


FIGURE 1-1

FACILITY LOCATION MAP

Alliance Refinery
Belle Chasse, Louisiana

2.0 Emission Reduction Projects

The Alliance Refinery is reducing emissions as required by the Consent Decree (Civil Action No. H-05-0285) that was entered into on December 5, 2005 between ConocoPhillips and the U.S. Environmental Protection Agency (EPA). The future planned emission reductions after completion of these projects are discussed in Section 2.1.

2.1 Currently Planned Emission Controls

The Alliance Refinery has reduced emissions since the 2001 to 2003 baseline period as part of the Consent Decree emission reductions. Additional emissions reductions will be achieved in the next few years as part of planned Alliance Refinery improvement projects and as required by the Consent Decree. Major planned emission reductions for the sources subject to BART engineering controls, the Fluidized Catalytic Cracker (FCC) and the Process Refinery Flares, are discussed below. A discussion in this section has been included to address LDEQ's request for information pertaining to additional planned emission reduction projects specifically for the Crude Unit Heater, (Point Source 191-H-1). Attachment III contains the LDEQ email correspondence requesting this additional information.

2.1.1 Currently Planned Emission Controls for the FCC

The Consent Decree requires the Alliance Refinery to reduce emissions of SO_2 from the Alliance Refinery's FCC. This emission reduction will be accomplished by the installation of a Wet Gas Scrubber on the FCC by December 31, 2009 as dictated in the Consent Decree. The FCC regenerator vents to the Alliance Refinery's two CO Boilers; therefore, the emission point sources for the FCC are the atmospheric stacks from the CO Boilers (Point Source 301-B-2A, & 301-B-2B). The CO Boilers burn both the FCC Regenerator flue gas and supplemental refinery fuel gas. Baseline SO_2 emissions were estimated as 550.24 lb/hr for each CO Boiler. It is estimated that future SO_2 emissions will be reduced to less than 275.12 lb/hr for each CO Boiler. It is expected that future average SO_2 emissions may be significantly lower than 275.12 lb/hr, but the exact emission rate cannot be defined until the Wet Gas Scrubber is commissioned.

2.1.2 Currently Planned Emission Controls for the Process Refinery Flares

The Consent Decree requires that by no later than December 31, 2011, the Alliance Refinery will accept NSPS Subpart J applicability for both flares and certify that the flares' emissions and operations comply with this standard. By compliance with this requirement, the Alliance Refinery will reduce emissions of SO_2 from the Alliance Refinery's Low Pressure and High Pressure Process Flares (Point Source 308F-D-1, & 308F-D-2). The control methods that the Alliance Refinery will implement on the flares are still under consideration; however, post control modeling results were based on reducing the flare emission rates from 2,374.56 lbs/hr to 87.91 lbs/hr. Per LDEQ's request, an excerpt from the Consent Decree is included in Attachment IV that lists the acceptable emissions control options in the Consent Decree that are allowed in order to meet the above emission reductions.

2.1.3 Currently Planned Emission Controls for the Crude Unit Heater

The Consent Decree requires the Alliance Refinery to reduce emissions of NO_x from the Alliance Refinery's combustion devices sources. To meet this emission reduction requirement the Alliance Refinery will install Selective Catalytic Reduction (SCR) on the Crude Unit Heater by December 31, 2008. It is estimated that future Crude Unit Heater NO_x emissions will be reduced from the baseline emissions of 294.17 lb/hr to 27.55 lb/hr.

2.1.4 Summary of Currently Planned Emission Controls Projects on Visibility

As a result of the installation of the emission control projects on the FCC and the process flares, SO_2 from these BART eligible sources will be reduced from an estimated 3,475.04 lb/hr to 638.15 lb/hr. This reduced SO_2 emission rate will result in the FCC and the Low Pressure Process Refinery Flares having less than a delta difference of 0.5 dv per each source. The High Pressure Process Flare and the Crude Unit Heater have less than a delta difference of 0.5 dv prior to controls being installed. The result of the installation of the emission control projects on the Crude Unit Heater as stated previously will reduce the NO_x emissions an estimated 90%.

All of these control requirements are considered more stringent than BART and are therefore considered to satisfy the regulatory requirements of the BART analysis.

2.2 Emission Reduction Costs of Planned Projects

ConocoPhillips is in the process of performing the engineering and design of the proposed projects; therefore, the costs below are estimates of anticipated capital expenditures and operating costs based on literature sources including John Zinc Presentations, EPA Air Pollution Control Cost Manual, and internal budgetary estimates. The estimated capital costs and operational costs are listed in Table 2-1.

Table 2-1 - Emission Reduction Costs of Planned Control Projects

Emission Reduction Project	Capital Cost Estimate	Annual Operating Cost
FCC Wet Gas Scrubber	$155,000,000.00	$4,500,000.00
Refinery Flare Gas Recovery*	$20,000,000.00	$182,000.00
Crude Unit Heater SCR	$35,000,000.00	$820,000.00
Total Estimated Cost	**$197,425,000.00**	**$5,502,000.00**

*The Flare Gas Recovery Control Option Cost was included for the process flares; however, the refinery has not chosen a control option.

2.3 Visibility Impacts

Visibility impacts for the baseline emission case and post controls are presented in Attachment I in the modeling report. Please note that the post control visibility impacts results do not include reductions associated with the installation of the SCR on the Crude Unit Heater. This emissions control project was not evaluated in the draft submittal to LDEQ; however, in subsequent conversations with Mr. James Orgeron of LDEQ, he expressed that it was not necessary to revise the visibility impacts analysis to include this project.

The above planned control projects target the most significant contributor to visibility impairment SO_2. According to a report to Congress titled Visibility in Mandatory Federal Class I Areas (1994-1998), EPA participated in the IMPROVE visibility monitoring program (Interagency Monitoring of Protected Visual Environments). During this program five major types of aerosols were measured at 30 monitoring sites. These sites are considered to be representative of all mandatory Federal Class I areas except the isolated Bering Sea Wilderness. The five aerosols measured were sulfates, nitrates, organic carbon, elemental carbon and crystal metal. The tests results showed that on an annual basis between 1994 and 1998, sulfate particles accounted for 23-78%; nitrate particles accounted for 3-39%, organic carbon for 9-28%, elemental carbon for 2-16% and crystal material accounted for 3-31 percent of the calculated light extinction. Therefore, as stated in the report, sulfate aerosols are generally formed in the atmosphere from sulfur dioxide. Thus by installing the emission controls on the FCC and Process Flares, Alliance Refinery is targeting the largest contributor to visibility impairment resulting in the highest impact on improving the visibility quality at the effected Class I area. Additional controls of the other BART eligible sources to reduce other pollutants would result in a significant impact on the visibility quality at the Class I area. For the baseline case, the number of days with impacts greater than 1.0 dv ranges from 30 days to 47 days, depending upon the year being modeled. Future emission controls already planned will reduce the number of days greater than 1.0 dv from 30 to 47 days to only 11 to 29 days, depending upon the year modeled. Similar results for the eighth highest delta dv show a reduction from a range of 2.34 dv to 3.61 for the baseline case to only 1.30 to 1.66 dv for the future planned case. Therefore, the currently planned emission reductions will provide a very large improvement in visibility, provide for reasonable further progress, and qualify for BART.

3.0 *Analysis for Controls on Other BART Eligible Sources*

The Alliance Refinery is reducing emissions as required by the Consent Decree (Civil Action No. H-05-0285) that was entered into on December 5, 2005 between ConocoPhillips and the U.S. Environmental Protection Agency (EPA). The potential controls and cost analyses for all other BART eligible sources not covered in the Consent Decree are discussed in this section.

For the purpose of analyzing the other BART Eligible sources, a linear relationship was assumed between emissions reductions and delta-deciview since post modeling was not performed for control options on these eligible sources. This assumption errs on the conservative side (i.e. over states the actual effect of the control option on the visibility) due to the fact that the 98th Percentile Delta-deciview value for these BART eligible sources is much lower than the BART eligible sources that the Alliance Refinery is proposing to install controls projects on. The FCC, Process Flares and Crude Unit Heater are the BART eligible sources with the highest Delta-deciview value per the Visibility Impact Chart Table below. Reducing the emissions on the other BART eligible sources will most likely not have a significant impact on decreasing the visibility impact on the Class I area.

Table 3-1 - 98th Percentile Delta-deciview Value

EPN	98th Percentile Delta-DV Value
308F-D-1	2.067
301-B-2A	0.760
301-B2-B	0.759
308F-D-2	0.540
191-H-1	0.485
303 -R-1	0.174
1391-H-4	0.096
191-H-2	0.094
491-H-2	0.066
891-H-1	0.061
491-H-1	0.056
1791-H-1	0.038
291-H-1	0.038

EPN	98th Percentile Delta-DV Value
1391-H-1	0.035
1391-H-2/3	0.033
291-H-2	0.030
1792-H-1	0.026
1291-H-2/3	0.025
293-H-2	0.014
293-H-1	0.011
406-D-15	0.010
406-D-16	0.010
292-H-2	0.009
292-H-1	0.005
891-CP	0.005
100-H-1	0.002
1391-H-5	0.002

3.1 Cooling Water Tower (Point Source 301-R-1) BACT for Particulate Matter (PM) and Particulate Matter Less Than Ten Microns (PM10)

3.1.1 Step 1 - Identify Available Control Technologies

The EPA's RACT/BACT/LAER Clearinghouse database, commonly known as the RBLC database includes determinations of the reasonably achievable control technology (RACT), best available control technology (BACT) and the lowest achievable emission rate technology (LAER). Based on research on the RBLC database, control technologies available for PM/PM_{10} emissions from cooling towers are identified as follows.

- High Efficiency Drift Eliminator (and high-end);
- Drift Eliminator; and
- Good Operating Practices.

High Efficiency Drift Eliminator (HEDE)

HEDEs are eliminators that are incorporated in a cooling tower design to provide a drift rate lower than the industrial standard of 0.005%. Results from the EPA RBLC research indicate that

HEDE can achieve drift rates range from 0.001% to 0.0001% on an annual basis. In general, higher efficiency drift eliminators will have high pressure drop which leads to higher energy requirements.

Drift Eliminator
Research indicates that drift eliminators are typically designed with drift eliminators having an efficiency of 0.005%.

Good Operating Practices
Good operating practices on cooling towers include maintaining equipment in good working order, and limiting solids buildup in the cooling water.

3.1.2 Step 2 – Eliminate Technically Infeasible Options

None of the available options identified above to control PM/PM_{10} emissions from cooling towers are deemed technically infeasible.

3.1.3 Step 3 – Ranking Technically Feasible Control Options Based on Effectiveness

The control effectiveness of the remaining control technologies is ranked from the most efficient to the least efficient in table below.

Table 3-2 - PM/PM_{10} Control Effectiveness Ranking

Type of Drift Eliminator	Drift Rate %	Drift Rate lb/Mgal	TDS ppm	PM Emissions TPY	PM Emission Reduction TPY	Control Effective-ness %	Ranking of Effective-ness
High Efficiency (high-end)	0.0001	-	1000	0.41	83.36	99.51%	1
High Efficiency	0.001	-	1000	4.11	79.66	95.09%	2
Drift Eliminator (industry standard)	0.005	-	1000	20.55	63.22	75.47%	3
Good Operating Practices (base case)	-	1.7	1000	83.77	-	-	4

3.1.4 Step 4 – Evaluate Most Cost Effective Controls

Economic analyses were performed for high-end HEDEs and HEDEs. Summaries for the cost effectiveness' are presented below. The cost analysis for both high-end HEDEs and HEDEs was obtained from the EPA Air Pollution Control Cost Manual, Sixth Edition, 2002 (EPA/452/B-02-001), Chapter 3, Electrostatic Precipitators (ESP). For the purposes of this analysis, it is assumed that HEDEs are operating on the similar principle as ESPs. The capital cost for the 0.001% HEDE was based upon an estimate of HEDEs for a comparable cooling tower. The capital cost for the 0.0001% HEDE was assumed to be twice as much as the estimate of the 0.001% HEDEs.

The cost analysis for high-end HEDEs and HEDEs are presented in following tables of this section. A summary of cost effectiveness for control equipment on PM/PM_{10} emissions from cooling tower is presented below.

Table 3-3 - Cost Analysis for HEDEs

	High-End HEDE	**HEDE**
Total Annualized cost	$76,373	$38,187
Expected PM/PM_{10} Visibility Reduction (dv)	0.173	0.165
Cost Effectiveness ($/dv)	**$441,462**	**$231,436**

As shown above, the levels of cost-effectiveness using high-end HEDEs and HEDEs to control PM/PM_{10} from the cooling tower are not an effective control to reduce overall visibility impact. Therefore, they are not considered cost-effective for retrofitting the cooling tower at the site.

3.1.5 Step 5 - Selection of BACT for PM_{10} Control

As previously demonstrated, retrofitting with HEDEs is technically feasible, but not economically feasible to control PM/PM_{10} emissions from the cooling tower at the site.

3.2 BACT for Nitrogen Oxides (NO_x) for Heaters

3.2.1 Step 1 - Identify Available Control Technologies and Step 2 - Eliminate Technically Infeasible Options

A search of the EPA's RBLC database and available state BACT links was conducted to identify recent permitting actions and BACT determinations.

The BART eligible sources heaters will fire refinery fuel gas and have maximum heat duties ranging from 45 MMBtu/hr to 267 MMBtu/hr. A search for heaters and boilers firing gaseous fuels in the range of heater duties between 100 to 250 MMBtu/hr was conducted. Control technologies identified in the search include the following:

- Selective catalytic reduction (SCR);
- Ultra-low NO_x burners (ULNB);
- Low NO_x burners (LNB);
- Flue gas recirculation (FGR);
- Selective non-catalytic reduction (SNCR); and
- Water injection.

Ultra-low NOx Burners and Low NOx Burners

Some common methods of combustion control for process heaters are staged combustion and flue gas recirculation. Low NO_x Burners (LNBs) typically use staged air or staged fuel combustion principles to minimize the amount of thermal NO_x formation. Staged combustion limits the amount of oxygen available to react with nitrogen at the combustion zones in the heater/firebox where temperature profiles favor thermal NO_x formation. Partial combustion occurs in the first stage and is then completed in subsequent stages. However, current industry practice is to install ULNBs on process heaters. Based on current practice and availability of burner designs LNB were not included in cost effectiveness evaluation for the subject process heaters in favor of UNLB.

Ultra Low NO_x Burners (ULNBs) use staged combustion principles similar to LNBs, but also have special designs which facilitate internal flue gas recirculation (FGR). FGR introduces a relatively cool, inert stream into the combustion zones where thermal NO_x formation is favored. This inert stream also contains less oxygen than primary combustion air which helps to limit the amount of oxygen available for thermal NO_x formation. ULNBs are potentially applicable NO_x controls for the process heaters in this BACT analysis.

Selective catalytic reduction (SCR) and Selective non-catalytic reduction (SNCR)

Common post-combustion controls that could be applicable to the process heaters and supplemental boiler in this BACT analysis include SCR and SNCR. SCR is a proven NO_x control technology that usually offers the greatest potential for NO_x reductions. Vendors will typically guarantee 70% to 90% reduction of inlet NO_x levels, but this is a function of inlet NOx loading. SCR is usually the highest cost post-combustion control, primarily because of the cost of the catalyst.

In SCR technology ammonia (NH_3) diluted with air or steam is injected into the flue gas upstream of a catalytic reactor. NH_3 reacts with NO_x in the presence of the catalyst to form nitrogen and water according to the following reactions:

$$4\ NO + 4\ NH_3 + 3\ O_2 \rightarrow 4\ N_2 + 6\ H_2O$$
$$2\ NO_2 + 4\ NH_3 + O_2 \rightarrow 3\ N_2 + 6\ H_2O$$

Operating temperature is highly important in SCR technology. The reactor must be operated at a temperature between 600 and 800°F. If the operating temperature is below this range, the catalyst activity is reduced allowing unreacted NH_3 to slip through. If the operating temperature is higher than this range, NH_3 may be oxidized forming additional NO_x and may cause the catalyst to become thermally stressed.

SNCR or the combination of SNCR with LNB/ULNB was not identified as a control technology from the RBLC search. SNCR requires a flue gas exit temperature in the range of 1200 to 2000°F, with an optimum operating exit temperature between 1600 and 2000°F. Process heaters typically have exhaust temperatures of ranging from 300 to 600°F. Therefore, additional fuel combustion or a similar energy supply would be needed to achieve exhaust temperatures compatible with SNCR operation. Additionally, with the lack of information demonstrating that SNCR can be used on process heaters, it is uncertain of the performance of SNCR on process heaters and the temperature restriction; therefore, SNCR was not included in cost effectiveness evaluation for the subject process heaters.

Flue gas recirculation

Flue gas recirculation (FGR) is a NO_x control technology that recycles 15% to 30% of the flue gas to the primary combustion zone. The recirculation dilutes the combustion reactants, reduces the peak temperature, and reduces the local oxygen concentrations. Thus, thermal NO_x formation is inhibited. FGR can only be used for a few select direct-fired heaters and typically is not cost effective due to increased energy costs; therefore, FGR was not included in cost effectiveness evaluation for the subject process heaters.

Water/Steam Injection

Water/steam injection involves the introduction of water/steam into the combustion zone of the burner. The water/steam acts as a thermal ballast which causes the peak flame temperature to be reduced, thereby limiting the thermal NO_x formation. Drawbacks of water/steam injection include increased equipment corrosion and reduced thermal and fuel efficiencies; therefore, water/steam injection was not included in cost effectiveness evaluation for the subject process heaters.

The technologies that are considered to be potentially applicable BACT options for NO_x control for the process heaters which are subject to BART are ULNB, ULNB and SCR and SCR. Use of these technologies will be evaluated further in the next step of the NO_x BACT analysis.

3.2.2 Step 3 – Ranking Remaining Control Options Based on Effectiveness

The NOx control technology alternatives that are considered technically feasible for the process heaters in this project are ranked in the order of most stringent to least stringent to form a control technology hierarchy.

Table 3-4 - NO_x Control Hierarchy

Type of NO_x Control	NOx Emission Factor (Lb/MMbtu)	Ranking of Effectiveness
Ultra Low NO_x Burners and SCR	0.0125	1
ULNB Low	0.03	2
SCR	0.036	3
Good Combustion Practices (base case)	Variable EFs	4

3.2.3 Step 4 – Evaluate Most Cost Effective Controls

Table 4 shows the resulting control technology hierarchy for the existing heaters that require a BACT analysis as a result of this BART Engineering Study.

Table 3-5 - NO_x Control Hierarchy for Existing Heaters

Source	Current Control (if any)	BACT Analysis Controls Reviewed	Selected Control	Estimated Delta-deciview Reduction	Estimated Cost Per Delta-deciview Reduction
1291-H-2/3(1)	ULNB	UNLB with SCR	UNLB with SCR	0.001784	**$910,509,147.26**
292-H-1	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.001837	**$557,941,799.83**
292-H-2	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.003306	**$331,860,637.44**
191-H-2	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.02115	**$116,745,393.95**
891-H-1	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.012994	**$130,404,469.84**
491-H-1	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.00972	**$154,659,337.53**
491-H-2	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.012375	**$133,219,460.22**
100-H-1	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.000735	**$1,321,121,598.34**
293-H-1	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.004041	**$285,144,661.02**
293-H-2	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.005143	**$235,644,544.88**
1391-H-1(1)	UNLB	UNLB with SCR	UNLB with SCR	0.010938	**$204,557,189.12**
1391-H-2/3(1)	UNLB	UNLB with SCR	UNLB with SCR	0.010313	**$215,285,533.97**
1391-H-4	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.010225	**$162,727,215.04**
1391-H-5	Good	UNLB and	UNLB with	0.00072	**$1,347,051,740.63**

Source	Current Control (if any)	BACT Analysis Controls Reviewed	Selected Control	Estimated Delta-deciview Reduction	Estimated Cost Per Delta-deciview Reduction
	Combustion	UNLB with SCR	SCR		
1791-H-1	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.007316	**$191,367,936.56**
1792-H-1(1)	UNLB	UNLB with SCR	UNLB with SCR	0.008125	**$192,785,285.47**
291-H-1	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.013959	**$101,529,812.07**
291-H-2	Good Combustion	UNLB and UNLB with SCR	UNLB with SCR	0.01102	**$119,238,993.62**

Economic impacts of installing Ultra Low NO_x burners were evaluated based on cost and performance information provided by John Zink Company. The total estimated cost effectiveness for installing new ULNB on all the above sources is $23,183,470.44 per dv of visibility improved. This value is clearly not cost effective. The total estimated cost effectiveness for installing SCR is $186,590,931.76 per dv of visibility improved. This value is clearly not cost effective.

3.2.4 Step 5 - Selection of BACT for NO_x Control

As previously demonstrated, retrofitting with ULNB or SCR is technically feasible, but not economically feasible to control NO_x emissions from the BART eligible process heaters. The proposed emission control projects, once installed, significantly reduced the effect of the Alliance Refinery on the visibility of the Class I area which satisfy the requirements of Regional Haze Rule Best Available Retrofit Technology.

ATTACHMENT I

SAGE
ENVIRONMENTAL CONSULTING

BART Refined Modeling For Baseline Emissions

Prepared for ConocoPhillips

ConocoPhillips

Alliance Refinery

Belle Chasse, LA

Sage Environmental Consulting, L.P.

May 2007

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SECTION 1
INTRODUCTION

1.1 Objectives

The objective of the refined Best Available Retrofit Technology (BART) modeling was to determine the potential visibility impairment impact of sulfur dioxide (SO_2), nitrogen oxides (NO_X), and inhalable particulate matter (PM_{10}) emissions from the Alliance Refinery operated by ConocoPhillips in Belle Chasse, LA on the Breton Wilderness Class I area. The purpose of refined modeling was to compare the predicted visibility impact of the Alliance Refinery BART-eligible units on the Breton Wilderness Class I area with the BART exemption threshold. If the modeled impact exceeds the threshold, the refined modeling was to be used in a BART engineering analysis to establish the pre-control baseline basis.

1.2 Facility Information and Relevant Class I Areas

ConocoPhillips owns and operates a petroleum refinery in Belle Chasse, Louisiana. The refinery will be further addressed as Alliance Refinery throughout this report. The refinery is located in Plaquemines Parish. The Louisiana Department of Environmental Quality (LDEQ) agency interest number for this facility is 2418.

The visibility impacts were evaluated for the Breton Wilderness Class I area per the pre-modeling protocol. This Class I area is located approximately 94 kilometers from Belle Chase, LA. The other three nearest Class I Areas (Caney Creek in Arkansas, Sipsey Wilderness in Alabama, and St. Marks Wilderness in Florida) are located well beyond 500 km from the refinery. The Alliance Refinery BART-eligible units have a greater probability of impacting visibility impairment at the Breton Wilderness Class I area than contributing to visibility impairment at other areas. Therefore, as agreed to by LDEQ in the modeling protocol discussed in Section 1.6 of this report, the only Breton Wilderness Class I area was evaluated.

1.3 Source Impact Evaluation Criteria

Refined modeling was performed for the years 2001-2003, as required by Central Regional Air Planning Association (CENRAP). The result of modeling was a measure of visibility conditions at the Breton Wilderness Class I area. The 98th percentile modeled value[1] was compared to the natural visibility conditions for the area. The impact depended on the difference between the modeled and natural visibility, measured in deciviews (dv). If the difference was less than 0.5 dv, the Alliance Refinery did not impact visibility at the Breton

[1] The *CENRAP BART Modeling Guidelines* document defines the 98th percentile modeled value as the "8th highest day annually at a receptor or 22nd highest [value] over 3 years" (p. 2-5).

Wilderness Class I area. Thus the refinery would then be exempt from further stages in the BART process. If however, the difference was greater than or equal to 0.5 dv, the Alliance Refinery would be considered a contributor to visibility impairment at the Breton Wilderness Class I area. The latter was the case; therefore, modeling was performed for individual BART-eligible units to evaluate the contribution of each unit to the visibility impairment. The contribution analysis allowed separating units subject to BART engineering analysis from units that do not significantly contribute to visibility impairment.

1.4 Relevant Air Quality Guidelines and Standards

Several guidance documents were used when performing BART modeling. The *CENRAP BART Modeling Guidelines*[2] specified the requirements of a refined modeling protocol and the years to model. The receptors for the Breton Wilderness Class I area were obtained from the National Park Service website. Tables 5 and 6 of the *BART Modeling Protocol* published by the LDEQ in February 2007 list relative humidity correction factors and annual natural levels of aerosol used to compute visibility. Two other guidance documents from the LDEQ were used to determine modeling requirements for Louisiana. The "Regional Haze Preliminary Plan" document identifies 0.5 deciviews as the visibility threshold, and the "BART Determination Process" document specifies Louisiana's requirements for a source to be subject to BART.

1.5 Qualifications and Experience of Sage Environmental

Sage Environmental Consulting, L.P. (Sage Environmental) provided the modeling for this project. Sage Environmental has comprehensive experience in various air dispersion modeling applications in the United States of America and world-wide. Sage Environmental provides full-service engineering and management consulting services in the areas of air permitting and compliance program development, atmospheric studies, infrastructure development, hazardous waste site investigation and remediation, air quality management, environmental assessment, permitting and compliance, pollution prevention, and environmental management systems.

Sage Environmental's air dispersion modeling team provides consulting services in the atmospheric sciences. The team specializes in non-steady-state modeling, photochemical modeling, dispersion model development, air quality permitting and licensing, modeling for accidental release, analysis of aerometric and emissions data, and regulatory consulting. The Sage Environmental's technical staff employs highly qualified scientists and consultants with exceptional depth and breadth of professional experience.

1.6 Modeling Protocol

A modeling protocol was submitted to the LDEQ, EPA Region VI, and Federal Land Managers (FLM) in February 2007 and is included in Attachment F. Mr. Patrick

[2] Dennis McNally, T. W. Tesche, and George Schewe, Alpine Geophysics, LLC. *CENRAP BART Modeling Guidelines*. Ft. Wright, Kentucky: December 15, 2005.

Pakunpanya of the Air Quality Assessment Division at LDEQ reviewed the protocol and sent comments to Sage Environmental on March 19, 2007. Sage Environmental revised the protocol to address the comments and resubmitted it in April 2007. The revised protocol was subsequently approved. Sage Environmental followed the revised protocol when performing the modeling.

On May 8, 2007, Ms. Jill Webster of the U.S. Fish and Wildlife Service provided additional comments to the previously approved modeling protocol. In her letter, Ms. Webster requested that Sage Environmental utilize meteorological data from overwater stations in the modeling and assure that all visibility impairing pollutants (i.e., sulfates, nitrates, and particulate matter) are included in computing total light extinction.

At the time the comments were received, the modeling analyses that used meteorological stations listed in the modeling protocol approved by the LDEQ were complete. These analyses demonstrated that the source was not exempt from BART compliance based on the modeling results. Since ConocoPhillips accepted a responsibility to conduct a BART engineering analysis and otherwise achieve compliance with the BART rule, inclusion of overwater stations in the modeling did not seem to be necessary. LDEQ personnel concurred with ConocoPhillips that the modeling that includes land stations would be sufficient to establish that the source is not exempt from BART engineering analysis and compliance.

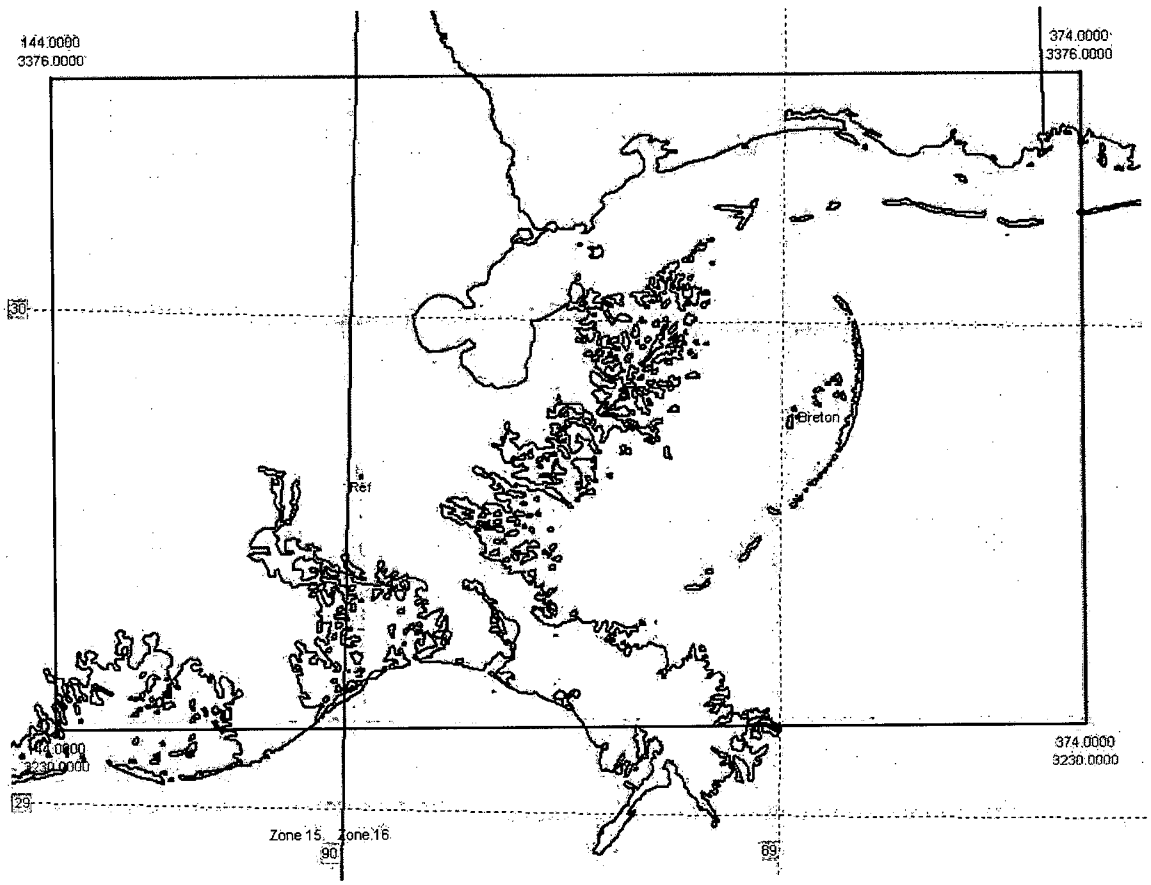
Additionally, Ms. Webster requested that in addition to sulfates and nitrates, contributions from particulate matter be included in the evaluation. Per this request, the completed modeling was revised to include three additional species in the modeling results presented in Section 6 and Appendix F of this report. However, it should be noted that all PM species combined contribute only slightly more than one (1) percent to the overall 98^{th} percentile visibility impacts created by the Alliance Refinery BART-eligible units. Therefore, the engineering analysis is focused on SO_2 and NOx emissions.

SECTION 2
MODEL INPUT DATA

2.1 Modeling Domain

The modeling domain is depicted in Figure 2-1. Each grid cell has the size 2 km by 2 km. The domain is a rectangle that includes all BART-eligible emission units, the Breton Wilderness Class I area, and a buffer extending at least 50 km in all directions from the boundaries of the Alliance Refinery and Class I area. The coordinates in the figure for the corners of the domain are UTM coordinates. The UTM coordinate system was used in the modeling. Lambert Conformal Conic and other system coordinates were converted into UTM coordinates as necessary.

Figure 2-1
Modeling Domain



The CALPUFF model has two domains: the meteorological domain and the computational domain. The meteorological domain determines the extent of meteorological data processed by CALMET. The computational domain determines how far CALPUFF tracks puffs and their concentrations. The computational domain can be a subset of the meteorological domain. For the refined BART modeling, the two domains were the same.

2.2 Terrain and Land Use

CALMET requires land use and terrain data in addition to weather observations. Sage Environmental obtained both sets of data for the modeling domain depicted in Figure 2-1. For terrain, Sage Environmental used the 3-arc-second data included in the Professional CALPUFF interface developed by BEE-Line Software. The data was originally obtained from the US Geological Survey (USGS). For land use, Sage Environmental obtained the 250K LULC data in CTG format from USGS. The USGS data set was supplemented with land use data for the continent of North America (available from the CALPUFF website[3]) to account for the lack of USGS data for the Gulf of Mexico.

2.3 Emissions Data

2.3.1 Species Modeled

Six species were modeled together in every CALPUFF simulation. The species are SO_2, SO_4, NO_X, HNO_3, NO_3, and PM_{10}. VOC and ammonia were not modeled per the LDEQ flowchart in the "BART Determination Process" document.[4] Emissions of inhalable particulate matter (with an effective diameter less than 10 micrometers) were speciated as recommended by the National Park Service[5] and as provided in Table 2-1.

Table 2-1
PM_{10} Speciation

PM_{10} Total	Filterable				
	Total	EC		Soil	
100.00%	46.00%	6.70%	of Filterable	93.30%	of Filterable
		3.08%	of Total	42.92%	of Total
	Condensable				
	Total	SO_4		SOA (OC)	
	54.00%	66.00%	of Condensable	34.00%	of Condensable
		35.64%	of Total	18.36%	of Total

[3]Atmospheric Studies Group. "Land Use/Land Cover (LULC) data." <u>ASG at TRC: Air Quality Modeling Data Sets</u>. July 10, 2006. http://www.src.com/datasets/datasets_lulc.html
[4] Louisiana Department of Environmental Quality. "BART Determination Process." Current Issues. No Date. http://www.deq.louisiana.gov/portal/Portals/0/AirQualityAssessment/bart.doc.
[5] National Park Service. "Particulate Matter Speciation." Explore Air. March 28, 2006. http://www2.nature.nps.gov/air/Permits/ect/index.cfm

2.3.2 BART-Eligible Units Modeled

In early 2006, ConocoPhillips submitted an emissions inventory to the LDEQ for BART-eligible unit emissions in 2001-2003 in response to the BART survey conducted by the LDEQ. The emission units and rates from this inventory were used in the refined BART modeling. Only BART-eligible units were included in the modeling. Twenty-seven (27) units were modeled, and 24-hour maximum potential emissions were used in lieu of the highest actual daily emissions for the 2001-2003 period. Appendix A lists the units modeled, along with the corresponding stack parameters and emission rates. Per the Louisiana modeling guidelines, potential visibility impacts at the Breton Wilderness Class I Area were initially determined for all BART-eligible units as a group. Since the predictions for the group exceeded 0.5 delta-dv, visibility impacts were obtained for each individual unit. Only units with impacts exceeding 0.5 delta-dv on the Breton Wilderness Class I Area will be considered for BART engineering analysis.

2.4 Meteorological Data

The meteorological preprocessor for CALPUFF is called CALMET. Sage Environmental developed CALMET data files for the years 2001-2003. Prognostic data for 2001 (36 km EPA), 2002 (12 km WRAP) and 2003 (36 km MRPO) were used for developing the Initial Guess Wind Fields in the CALMET model. The CALMM5 extraction from the prognostic data was supplied by BEE-Line Software. The 2001 and 2003 data cover the contiguous United States at a spacing of 36 km. The 2002 data cover the western portion of the contiguous United States at a spacing of 12 km. In addition to the CALMM5 data, observations were used to develop the Step 2 Wind Fields, including surface, upper air, and precipitation weather observations. The stations from which observations were obtained are listed in Section 3.8.

2.5 Air Quality Data

Ammonia concentrations were held constant per the LDEQ *BART Modeling Protocol*.[6] The value of 3 ppb was always used for ammonia concentrations. When calculating light extinction, relative humidity correction factors (*f*(RH)s) provided by CENRAP and listed in Table 2-2 were entered into CALPOST.

Table 2-2
Monthly Averaged *f*(RH)

Class I Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breton Wilderness	3.7	3.5	3.7	3.6	3.8	4.0	4.3	4.3	4.2	3.7	3.7	3.7

[6] Louisiana Department of Environmental Quality (February 2007). *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana*, p. 11.

Sage Environmental used ozone concentration files provided by LDEQ.[7] Three files have been provided, each containing ozone concentration data for one year. A default value of 40 ppb was used for hours in which ozone data were missing.

Sage Environmental pre-processed the ozone files in two ways. The version of CALPUFF used in the modeling required ozone station coordinates within the ozone concentration files to be UTM coordinates. The files provided had Lambert Conformal Conic (LCC) coordinates, so the coordinates were converted to UTM. In the ozone concentration file for 2002, ozone observations included stations for the entire CENRAP South domain. The number of stations was too large for CALPUFF to process, so the file was modified to only contain data for a 50-km region surrounding the modeling domain.

2.6 Natural Conditions at Class I Areas

CALPOST uses monthly concentrations of aerosol components to compute background extinction coefficients. Sage Environmental used the levels provided by CENRAP and listed in Table 2-3 when performing BART refined modeling.

Table 2-3
Average Annual Natural Levels of Aerosol Components (μg/m^3)

Class I Area	SO4	NO3	OC	EC	Soil	Coarse Mass
Breton Wilderness	0.23	0.10	1.40	0.02	0.50	3.00

[7] Louisiana Department of Environmental Quality. *Ozone Data.* March 1, 2007. ftp://ftp-cenrap.ldeq.org/ozonedata.zip

SECTION 3
CALMET MODELING METHODOLOGY

This section of the report describes the configuration settings for CALMET, the meteorological pre-processor for the CALPUFF model. Default CALMET settings were used, with the exceptions described in this section. Sage Environmental ran CALMET for each of the three years modeled (with the settings specified below) and produced output files in the CALMET.DAT format. Twelve files were produced for each year, one meteorological data file for each month. The same set of CALMET output files was then used for all CALPUFF model runs.

3.1 Meteorological Domain

The meteorological domain is a system of regular-spaced grid points at which meteorological parameters (wind components, mixing heights, etc.) are defined. The meteorological domain is determined by the grid formed in the meteorological preprocessor CALMET. The origin of the meteorological domain is the basic reference frame for all spatial input data to both CALMET and CALPUFF (e.g., coordinates of meteorological stations, sources, and receptors).

The domain depicted in Figure 2-1 is the meteorological domain used for all CALMET runs. Table 3-1 contains the CALMET variable values defining the domain.

Table 3-1
Meteorological Domain Settings

Variable	Value	Definition
PMAP	UTM	Map projection
IUTMZN	16	UTM zone
UTMHEM	N	Hemisphere
DATUM	WGS-G	National Imagery and Mapping Agency (NIMA) datum-region
NX	115	Number of x grid cells
NY	73	Number of y grid cells
DGRIDKM	2	Grid spacing in kilometers
XORIGKM	144	X coordinate of the southwest corner of the domain
YORIGKM	3230	Y coordinate of the southwest corner of the domain

3.2 Terrain

TERREL is the pre-processor for terrain data. This program accepts terrain surface elevation data from a number of digital data bases and forms grid-cell averages or point-values for use in CALMET and CALPUFF. TERREL produces a gridded terrain file for the MAKEGEO pre-processor, which then creates the geophysical data file GEO.DAT used by CALMET.

A single run of TERREL was necessary to process the terrain data. The map projection variables in TERREL were set to the appropriate values in Table 3-1. The IMODEL variable was set to 1 so that the output file format would be compatible with CALMET.

3.3 Land Use

CTGPROC is the pre-processor for land use data. The program reads a Land Use and Land Cover (LULC) data file and determines fractional land use for each grid cell in the meteorological domain. The domain required multiple land use files, so CTGPROC was applied iteratively (run several times) to build the land use grid incrementally. The land use file for the continent of North America was processed last, so that it filled the gaps in USGS land use data. The map projection variables in CTGPROC were set to match the variables in Table 3-1. The LULC variable, which indicates the type of file processed, was set to 1 (USGS CTG files) when processing USGS data and to 2 (USGS Global files) when processing the North American continent data.

3.4 Vertical Layer Structure

The vertical layer structure is defined by two variables in CALMET, NZ and ZFACE. NZ is the number of vertical layers, and ZFACE is an array containing cell face heights in meters. The value of the NZ variable was set to 12. The values for the ZFACE option were set to 0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1000 m, 1200 m, 1500 m, 2000 m, 3000 m, and 4000 m per the pre-modeling protocol.

3.5 Diagnostic Model Settings

When developing CALMET data files, Sage Environmental changed the following default settings that determine processing of wind fields. The variable IWFCOD was set to 1 to use CALMET's diagnostic wind module. The variable IPROG was set to 14 to utilize CALMM5 data files in developing the initial guess field.

3.6 BIAS, RMIN2, IXTERP Settings

The BIAS variable affects how the initial winds are interpolated to each grid cell in each vertical layer, based on surface and upper air observations. This variable was set to an array of twelve zeroes, corresponding to the number of vertical layers. The result is that surface and upper air observations were given equal weight. The RMIN2 variable was set to -1 and the IEXTRP variable was set to -4 to extrapolate surface wind observations to upper layers.

3.7 TERRAD, R1, R2, RMAX1, RMAX2, RMAX3 Settings

CALMET uses the listed variables to construct the Step 2 wind field. Table 3-2 lists the values to which the variables were set in the CALMET input files per the pre-modeling protocol. The values all represent distances in kilometers.

Table 3-2
Wind Field Settings

Variable	Value	Definition
TERRAD	25	Radius of influence of terrain features
R1	20	Distance from a surface station at which the observation and the first guess field are equally weighted
R2	50	Distance from an upper air station at which the observation and the first guess field are equally weighted
RMAX1	100	Maximum radius of influence over land in the surface layer
RMAX2	200	Maximum radius of influence over land aloft
RMAX3	300	Maximum radius of influence over water

3.8 Weather Stations

Sage Environmental obtained observational data from one upper air station (Slidell, LA, WBAN number 53813), fourteen surface stations, and ten precipitation stations.[8] The stations are listed in Table 3-3. Anemometer heights were set to 10 meters for all surface stations. No overwater station observations were used.

Some of the data for the upper air station were missing and were replaced as follows. Each year was treated independently of the other years. If a day of data was missing, it was filled with data from the previous day. Data missing on January 1 was filled with data from January 2 for each year. If two days were missing, data from the day before the first missing day was used to fill the first missing day and data from the day after the second missing day was used to fill the second missing day. There were no periods in the modeled years when more than two consecutive days were missing.

If CALMET indicated that there were errors in the data, the modeler corrected them. If the errors could not be easily corrected, the data was replaced with data from the previous day. The corrections and replacements of data are listed in Appendix E.

[8] Observations from eight precipitation stations were used for the years 2001 and 2002. Observations from all ten precipitation stations were used in 2003.

Table 3-3
WBAN Stations Used for CALMET Processing

WBAN ID	Station Name	State	Type of Data
12884	Boothville	LA	Surface
12916	New Orleans International Airport	LA	Surface, Precipitation
12936	Patterson	LA	Surface
12968	Salt Point	LA	Surface
13820	Keesler	MS	Surface
13838	Mobile	AL	Surface
13894	Mobile Airport	AL	Surface, Precipitation
13943	New Orleans	LA	Surface
13970	Baton Rouge Ryan Airport	LA	Surface
53813	Slidell	LA	Surface, Upper Air
53858	Pascagoula	MS	Surface
93874	Gulfport-Biloxi	MS	Surface
Not available	Dauphin Island #2	AL	Surface, Precipitation
Not available	Southwest Pass	LA	Surface
Not available	LSU Citrus Research Station	LA	Precipitation
Not available	New Orleans Audubon	LA	Precipitation
Not available	Hammond	LA	Precipitation
Not available	Slidell WSFO	LA	Precipitation
Not available	Biloxi	MS	Precipitation
Not available	Pascagoula	MS	Precipitation
Not available	Saucier Exp Forest	MS	Precipitation

SECTION 4
CALPUFF MODELING METHODOLOGY

4.1 Model Selection

The California Puff (CALPUFF) air dispersion modeling system used in this modeling analysis is a multi-layer, multi-species, non-steady state puff dispersion model which can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF uses three-dimensional meteorological fields computed by the CALMET meteorological preprocessor. CALPUFF contains algorithms for taking into account near-source effects such as building downwash, transitional plume rise, partial plume penetration, and sub-grid scale terrain interactions as well as longer range effects such as pollutant removal (wet scavenging or dry deposition), chemical transformation, vertical wind shear, and over-water transport.

By its puff-based formulation and through the use of three-dimensional meteorological data developed by the CALMET meteorological preprocessor, CALPUFF can simulate the effects of time- and space-varying meteorological conditions on pollutant transport from point, volume, area, and line sources in complex terrain.

Table 4-1
Versions of the Modeling Software

Program Name	Version	Level
CTGPROC	2.4	030402
TERREL	3.3	030402
MAKEGEO	2.2	030402
READ62	5.5	030402
PMERGE	5.3	030402
PXTRACT	4.2	030402
SMERGE	5.56	050324
CALMET	5.53a	040716
CALPUFF	5.711a	040716
POSTUTIL	1.3	030402
CALPOST	5.51	030709

Sage Environmental used EPA-approved versions of the CALPUFF, CALPOST, and POSTUTIL programs listed in Table 4-1. These programs and their pre-processors were obtained from the CALPUFF website[9] and were then recompiled as recommended by

[9] Atmospheric Studies Group. "Codes and Related Processors: EPA-Approved Version." January 16, 2007. http://www.src.com/calpuff/download/p2.htm

LDEQ[10]. The parameter files for all three programs were modified; the modified file printouts are provided in Appendix C. Sage Environmental used version 2.34.1 of the Professional CalPuff graphical user interface developed by BEE-Line Software to create model input files. Three annual simulations were performed for the years 2001-2003.

4.2 Computational Domain and Receptor Grid

As discussed in Section 2.1, the computational domain is the same as the meteorological domain. It is defined by the CALPUFF variables in Table 4-2, and has the same 2 km by 2 km spacing as the meteorological domain.

Table 4-2
Computational Domain Settings

Variable	Value	Definition
IBCOMP	1	X index of lower left corner
JBCOMP	1	Y index of lower left corner
IECOMP	115	X index of upper right corner
JECOMP	73	Y index of upper right corner

The receptors were the set of Class I area receptors developed by the National Park Service. There were 40 receptors covering the Breton Wilderness Class I area, spaced approximately 1 km from each other. When running CALPUFF, only the receptors for this Class I area were included.

4.3 CALPUFF Configuration

4.3.1 Subgrid-scale complex terrain

An optional module in CALPUFF, Complex Terrain Sub-grid (CTSG), treats terrain features that are not resolved by the gridded terrain field. This module utilizes calculation routines that are based on the Complex Terrain Dispersion Model (CTDMPlus). Sage Environmental did to not use this option as dictated in the pre-modeling protocol by setting the CALPUFF variable MCTSG to 0.

4.3.2 Chemical Mechanism

CALPUFF includes options for assessing chemical transformation effects using the five species scheme (SO_2, SO_4, NO_x, HNO_3, and NO_3) employed in the MESOPUFF II model; the six species RIVAD scheme (SO_2, SO_4, NO, NO_2, HNO_3, and NO_3); or a set of user-specified, diurnally-varying transformation rates. Sage Environmental set the CALPUFF variable MCHEM to 1 to use the MESOPUFF II chemical transformation scheme.

[10] Louisiana Department of Environmental Quality (February 2007). *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana*, p. 8.

4.3.3 Building Downwash

The Huber-Snyder and Schulman-Scire (ISC3) downwash models and the PRIME building downwash algorithm are both incorporated into CALPUFF computation routines. Both algorithms have been implemented in such a way as to allow the use of wind direction-specific building dimensions. The use of downwash algorithms is optional. Since buildings and other solid structures only affect plume dispersion out to approximately 10 building/structure heights downwind of the structure and the Breton Wilderness Class I area is approximately 94 km away from the Alliance Refinery, Sage Environmental did not include building downwash effects in the modeling analysis.

4.3.4 Puff Splitting

CALPUFF contains an optional puff splitting algorithm that allows vertical wind sheer effects across individual puffs to be simulated. Differential rates of dispersion and transport occur on the puffs generated from the original puff, which under some conditions can substantially increase the effective rate of horizontal growth of the plume. Sage Environmental did to not use this option by setting the CALPUFF variable MSPLIT to 0.

4.3.5 Sampling Grid

CALPUFF contains an option to place additional receptors within the computational domain. Since only the Breton Wilderness Class I area is being modeled, Sage Environmental did to not use this option by setting the CALPUFF variable LSAMP to F.

4.3.6 Dispersion Coefficients

Several options are provided in CALPUFF for the computation of dispersion coefficients, including the use of turbulence measurements (σ_v and σ_w), the use of similarity theory to estimate σ_v and σ_w from modeled surface heat and momentum fluxes, or the use of Pasquill-Gifford (PG) or McElroy-Pooler (MP) dispersion coefficients, or dispersion equations based on the Complex Terrain Dispersion Model (CTDMPlus). Options are provided to apply an averaging time correction or surface roughness length adjustments to the PG coefficients. Sage Environmental utilized PG dispersion coefficients as the CALPUFF default option for rural type of dispersion by setting the variable MDISP to 3.

4.3.7 Dry Deposition

A full resistance model is provided in CALPUFF for the computation of dry deposition rates of gases and particulate matter as a function of geophysical parameters, meteorological conditions, and pollutant species. Options are provided to allow user-specified, diurnally varying deposition velocities to be used for one or more pollutants instead of the resistance model (e.g., for sensitivity testing) or to by-pass the dry deposition model completely. For particles, source-specific mass distributions may be provided for use in the resistance model. Sage Environmental included dry deposition effect calculations by setting the CALPUFF variable MDRY to 1.

4.3.8 Wet Removal

An empirical scavenging coefficient approach is used in CALPUFF to compute the depletion and wet removal fluxes due to precipitation scavenging. The scavenging coefficients are specified as a function of the pollutant and precipitation type (i.e., frozen vs. liquid precipitation). Sage Environmental included wet removal effect calculations by setting the CALPUFF variable MWET to 1.

SECTION 5
POST PROCESSING METHODOLOGY

5.1 POSTUTIL Configuration

Following each CALPUFF run, the POSTUTIL post-processor program was run to compute the HNO_3/NO_3 partition of concentrations. This computation used the ammonia limiting method, with the background ammonia concentration set to 3 ppb, as discussed in Section 2.5. The MNITRATE variable was set to 1 to compute the partition and the BCKNH3 variable was set to 3.

5.2 CALPOST Configuration

The CALPOST post-processor program was run after POSTUTIL to obtain the daily delta-deciview values indicating the visibility impact of the Alliance Refinery on the Breton Wilderness Class I area. CALPOST produced both light extinction values and delta-deciview values. The settings in Table 5-1 were used for visibility processing of the concentrations computed by POSTUTIL.

Table 5-1
CALPOST Settings

Variable	Value	Definition
METRUN	1	Run for all dates in POSTUTIL output file
ASPEC	VISIB	Visibility processing
LD	T	Process discrete receptors
LVSO4	T	Process sulfate
LVNO3	T	Process nitrate
LVOC	T	Process organic carbon
LVPMC	F	Do not process coarse particles
LVPMF	T	Process fine particles
LVEC	T	Process elemental carbon
SPECPMF	SOIL	Species name used for fine particles
MVISBK	6	Method used for background light extinction
IPRTU	3	Output units are $\mu g/m^3$
L24HR	T	Output 24-hour averages

After running CALPOST for each year, the yearly results were combined to obtain the 98^{th} percentile delta-deciview value for all BART-eligible units combined and for each individual BART-eligible unit. The delta-deciview values for each year were sorted in descending order, and the first eight values were extracted. After obtaining twenty-four values from three years of results, the 22^{nd} highest value was computed. This value was then compared with the 0.5 delta-deciview threshold.

SECTION 6
MODELING RESULTS

This section contains a summary of the modeling results. See Appendix F for the details.

6.1 Visibility Impacts

When the BART-eligible units at the Alliance Refinery are considered together as a group, their combined impact on the Breton Wilderness Class I area is 2.689 delta-deciviews. This is the 98th percentile value for the years 2001-2003. Since the value is above the 0.5 delta-deciview threshold, the Alliance Refinery BART-eligible units were determined to contribute to visibility impairment at the Breton Wilderness Class I area.

6.2 Contribution Analysis

After determining that the Alliance Refinery contributes to visibility impairment, Sage Environmental ran CALPUFF again for each BART-eligible unit within the refinery. It was determined that three units have impacts greater than 0.5 delta-deciview. The units are: EPN 301-B-2A (CO boiler), with an impact of 0.530 delta-deciview; EPN 301-B-2B (CO Boiler), with an impact of 0.529 delta-deciview; and EPN 308F-D-1 (low-pressure flare), with an impact of 1.033 delta-deciview. The other units all have impacts not exceeding the 0.5 delta-deciview threshold.

Additional modeling runs were conducted to determine the contribution of different species (i.e, sulfates, nitrates, and particulate matter) to the overall visibility impairment impact created by the BART-eligible units. The runs demonstrated that approximately 77% of visibility impairment in 2001-2003 can be attributed to sulfur dioxide, 22% can be attributed to nitrogen oxides emissions, and all particulate species contributed approximately 1% to the overall impacts. Based on this analysis, ConocoPhillips proposes to focus their BART engineering analysis to address emissions reductions for sulfur dioxide.

SECTION 7
POST CONTROL MODELING RESULTS

This section contains a summary of the post-control modeling results. See Appendix F for the details.

7.1 Visibility Impacts

When the BART-eligible units at the Alliance Refinery are considered together as a group, their combined post-control impact on the Breton Wilderness Class I area is 1.444 delta-deciviews. This is the 98^{th} percentile value for the years 2001-2003. The value is above the 0.5 delta-deciview threshold.

7.2 Contribution Analysis

Sage Environmental analyzed the contributions of the BART-eligible units for which emission rates were reduced as a control mechanism. The units are: EPN 301-B-2A (CO boiler); EPN 301-B-2B (CO Boiler); and EPN 308F-D-1 (low-pressure flare); and EPN 308F-D-2 (high-pressure flare). These units all have impacts not exceeding the 0.5 delta-deciview threshold after controls are applied.

SECTION 8
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APPENDIX A
EMISSIONS DATA

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana
List of BART- Eligible Units Included in BART Modeling

EPN	Description	Source ID	UTM	UTM	Zone	Stack	Base	Stack	Exit	Exit	Init.	Init.	Momentum
			Easting (X)	Northing (Y)		Height	Elevation	Diameter	Velocity	Temp.	Sigma-y	Sigma-z	Flux
			(km)	(km)		(m)	(m)	(m)	(m/s)	(K)	(m)	(m)	
1291-H-2/3	FCCU Light/Heavy Feed Heater	1291H23	212.246	3287.375	16	56.7	1.22	2.59	4.08	552	0	0	1
301-B-2A	CO Boiler	301B2A	212.232	3287.396	16	23.8	1.22	3.51	20.49	609.3	0	0	1
301-B-2B	CO Boiler	301B2B	212.21	3287.389	16	23.8	1.22	3.51	20.99	582	0	0	1
292-H-1	Light Distillate Gulfiner Reactor Heater	292H1	212.037	3287.241	16	28	0.61	1.22	2.44	595.9	0	0	1
292-H-2	Light Distillate Gulfiner Stabilizer Heater	292H2	212.032	3287.254	16	36.9	0.66	1.6	2	597	0	0	1
191-H-1	Crude Charge Heater	191H1	212.092	3287.117	16	63.7	0.61	4.69	8.05	465.9	0	0	1
191-H-2	Vacuum Charge Heater	191H2	212.103	3287.09	16	63.7	0.61	2.74	4.4	449.3	0	0	1
406-D-15	Product Dock No.1 MVR Loading	406D15	212.61	3286.993	16	7.6	1.52	0.79	20	1273.2	0	0	1
406-D-16	Product Dock No.2 MVR Loading	406D16	212.612	3286.984	16	7.6	1.52	0.79	20	1273.2	0	0	1
891-H-1	Delayed Coker Charge Heater	891H1	212.395	3287.189	16	50.3	1.22	2.29	6.01	605.4	0	0	1
891-CP	Coke Transfer and Storage	891CP	212.397	3287.217	16	1.00	1.22	1.00	0.001	298.15	0	0	1
491-H-1	Alkylation Isostripper Reboiler	491H1	212.252	3287.133	16	51.2	0.91	3.12	2.5	615.9	0	0	1
491-H-2	Alkylation Depropanizer Reboiler	491H2	212.269	3287.139	16	43	0.91	3.05	4.48	574.3	0	0	1
100-H-1	Coker Charge Storage Heater	100H1	212.47	3287.281	16	15.2	1.94	0.61	6.07	594.3	0	0	1
293-H-1	Heavy Distillate Gulfiner Reactor Feed Heater	293H1	212.051	3287.2	16	39.6	0.61	2.03	2.68	577.6	0	0	1
293-H-2	Heavy Distillate Gulfiner Stabilizer Reboiler	293H2	212.055	3287.187	16	34.4	0.61	1.92	4.42	603.7	0	0	1
1391-H-1	Catalytic Reformer Feed Heater No. 1	1391H1	212.015	3287.43	16	62.8	0.91	3.51	4.76	490.4	0	0	1
1391-H-2/3	Catalytic Reformer Feed Heater No. 2 & 3	1391H23	212.051	3287.443	16	65	0.91	3.93	3.75	763.1	0	0	1
1391-H-4	Depentanizer Reboiler	1391H4	212.025	3287.433	16	44.2	0.91	2.18	6.34	550.4	0	0	1
1391-H-5	Dry Reactivation Heater	1391H5	212.07	3287.45	16	42.2	0.91	2.2	1.49	550.4	0	0	1
1791-H-1	Reformate Splitter Reboiler	1791H1	212.056	3287.319	16	38.1	0.91	1.96	3.5	552	0	0	1
1792-H-1	Hydrodealkylation Charge Heater	1792H1	212.027	3287.269	16	45.1	0.7	2.29	4.24	552	0	0	1
291-H-1	Naphiner Reactor Feed Heater	291H1	212.042	3287.227	16	39.6	0.64	1.92	2.99	599.3	0	0	1
291-H-2	Naphiner Deisohexanizer Reboiler	291H2	212.045	3287.214	16	38.7	0.61	1.93	3.66	541.5	0	0	1
303-R-1	Cooling Water Tower No. 1	303R1P	212.177	3287.033	16	18.288	0.61	8.5344	8.534	303.15	0	0	1
308F-D-1	Low Pressure Flare	308FD1	212.51	3286.983	16	65	1.22	3.07	20	1273.2	0	0	1
308F-D-2	High Pressure Flare	308FD2	212.569	3286.81	16	65	1.09	2.15	20	1273.2	0	0	1

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana
List of BART- Eligible Units Included in BART Modeling

EPN	Description	Source ID	SO_2	SO_2	SO_4	SO_4	NO_X	NO_X	EC	EC	Soil	Soil	OC	OC
			(g/s)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(lb/hr)
1291-H-2/3	FCCU Light/Heavy Feed Heater	1291H23	0.6792	5.3903	0.0668	0.5304	1.0097	8.0138	0.0058	0.0458	0.0805	0.6387	0.0344	0.2732
301-B-2A	CO Boiler	301B2A	69.3287	550.2371	2.3925	18.9884	19.1319	151.8434	0.2068	1.6410	2.8812	22.8671	1.2325	9.7819
301-B-2B	CO Boiler	301B2B	69.3287	550.2371	2.3925	18.9884	19.0972	151.5678	0.2068	1.6410	2.8812	22.8671	1.2325	9.7819
292-H-1	Light Distillate Gulfiner Reactor Heater	292H1	0.0930	0.7383	0.0094	0.0746	0.3389	2.6896	0.0008	0.0065	0.0113	0.0899	0.0048	0.0385
292-H-2	Light Distillate Gulfiner Stabilizer Heater	292H2	0.1636	1.2982	0.0163	0.1296	0.5958	4.7289	0.0014	0.0112	0.0197	0.1561	0.0084	0.0668
191-H-1	Crude Charge Heater	191H1	19.7917	157.0794	0.4538	3.6013	40.8565	324.2632	0.0392	0.3112	0.5464	4.3369	0.2338	1.8552
191-H-2	Vacuum Charge Heater	191H2	1.5042	11.9380	0.1485	1.1786	8.9472	71.0109	0.0128	0.1019	0.1788	1.4193	0.0765	0.6072
406-D-15	Product Dock No.1 MVR Loading	406D15	0.0056	0.0441	0.0238	0.1886	0.8819	6.9997	0.0021	0.0163	0.0286	0.2271	0.0122	0.0971
406-D-16	Product Dock No.2 MVR Loading	406D16	0.0056	0.0441	0.0238	0.1886	0.8819	6.9997	0.0021	0.0163	0.0286	0.2271	0.0122	0.0971
891-H-1	Delayed Coker Charge Heater	891H1	0.8967	7.1165	0.0886	0.7032	5.6333	44.7097	0.0077	0.0608	0.1067	0.8469	0.0456	0.3623
891-CP	Coke Transfer and Storage	891CP	0.0000	0.0000	0.0262	0.2082	0.0000	0.0000	0.0023	0.0180	0.0316	0.2507	0.0135	0.1073
491-H-1	Alkylation Isostripper Reboiler	491H1	0.8069	6.4044	0.0663	0.5264	5.1847	41.1493	0.0057	0.0455	0.0799	0.6340	0.0342	0.2712
491-H-2	Alkylation Depropanizer Reboiler	491H2	1.0111	8.0248	0.0832	0.6600	6.0167	47.7521	0.0072	0.0570	0.1001	0.7948	0.0428	0.3400
100-H-1	Coker Charge Storage Heater	100H1	0.0403	0.3197	0.0040	0.0314	0.1472	1.1684	0.0003	0.0027	0.0048	0.0378	0.0020	0.0162
293-H-1	Heavy Distillate Gulfiner Reactor Feed Heater	293H1	0.1812	1.4381	0.0238	0.1886	0.7917	6.2832	0.0021	0.0163	0.0286	0.2271	0.0122	0.0971
293-H-2	Heavy Distillate Gulfiner Stabilizer Reboiler	293H2	0.2298	1.8236	0.0272	0.2161	1.0042	7.9697	0.0024	0.0187	0.0328	0.2602	0.0140	0.1113
1391-H-1	Catalytic Reformer Feed Heater No. 1	1391H1	1.2778	10.1413	0.1262	1.0018	1.9000	15.0796	0.0109	0.0866	0.1520	1.2064	0.0650	0.5161
1391-H-2/3	Catalytic Reformer Feed Heater No. 2 & 3	1391H23	1.2611	10.0090	0.1242	0.9861	1.8750	14.8812	0.0107	0.0852	0.1496	1.1875	0.0640	0.5080
1391-H-4	Depentanizer Reboiler	1391H4	0.7167	5.6879	0.0708	0.5618	9.0139	71.5400	0.0061	0.0486	0.0852	0.6766	0.0365	0.2894
1391-H-5	Dry Reactivation Heater	1391H5	0.0389	0.3086	0.0040	0.0314	0.1431	1.1354	0.0003	0.0027	0.0048	0.0378	0.0020	0.0162
1791-H-1	Reformate Splitter Reboiler	1791H1	0.4597	3.6487	0.0455	0.3614	3.1944	25.3532	0.0039	0.0312	0.0548	0.4353	0.0235	0.1862
1792-H-1	Hydrodealkylation Charge Heater	1792H1	0.6222	4.9384	0.0614	0.4872	0.9250	7.3414	0.0053	0.0421	0.0739	0.5867	0.0316	0.2510
291-H-1	Naphiner Reactor Feed Heater	291H1	0.4764	3.7809	0.0470	0.3732	3.2986	26.1799	0.0041	0.0323	0.0566	0.4495	0.0242	0.1923
291-H-2	Naphiner Deisohexanizer Reboiler	291H2	0.3750	2.9762	0.0371	0.2946	2.6000	20.6353	0.0032	0.0255	0.0447	0.3548	0.0191	0.1518
303-R-1	Cooling Water Tower No. 1	303R1P	0.0000	0.0000	0.9870	7.8337	0.0000	0.0000	0.0853	0.6770	1.1886	9.4339	0.5085	4.0355
308F-D-1	Low Pressure Flare	308FD1	236.1111	1873.9292	0.0020	0.0157	3.3565	26.6392	0.0002	0.0014	0.0024	0.0189	0.0010	0.0081
308F-D-2	High Pressure Flare	308FD2	63.0787	500.6331	0.0020	0.0157	1.3889	11.0231	0.0002	0.0014	0.0024	0.0189	0.0010	0.0081

APPENDIX B
CALPUFF SPECIES DEFINITION FILE

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana
CALPUFF Species Parameters for Refined BART Modeling

	Dry (Gas)					Dry (Particle)		Wet	
Species	Diffusivity	Alpha Star	Reactivity	Meso. Resist.	Henry's Law	Geo. Mass Mean Diameter	Geometric Standard Deviation	Scavenging Coef. Liquid Precip.	Scavenging Coef. Frozen Precip.
	(cm^2/s)			(s/cm)		(microns)	(microns)	(1/s)	(1/s)
SO2	0.1509	1000	8	0	0.04	0	0	3.00E-05	0
SO4	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05
NOX	0.1656	1	8	5	3.5	0	0	0	0
HNO3	0.1628	1	18	0	8.00E-08	0	0	6.00E-05	0
NO3	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05
EC	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05
SOIL	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05
SOA	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05

APPENDIX C
PARAMETER FILES FOR CALPUFF, POSTUTIL, AND CALPOST

```
c-----------------------------------------------------------------------
c     CALPUFF PARAMETERS
c-----------------------------------------------------------------------

c --- Specify model version
      character*12 mver, mlevel, mmodel
      parameter(mver='5.711a',mlevel='040716')
      parameter(mmodel='CALPUFF')

c --- Specify parameters
      parameter(mxpuff=100000)
      parameter(mxspec=20)
      parameter(mxnx=388,mxny=265,mxnz=16)
      parameter(mxnxg=265,mxnyg=265,mxrec=10000)
      parameter(mxrfog=40)
      parameter(mxss=350,mxus=99,mxps=700)
      parameter(mxpt1=200,mxpt2=200,mxarea=200,mxvert=5)
      parameter(mxlines=24,mxlngrp=1,mxvol=200)
      parameter(mxrise=50)
      parameter(mxpdep=9,mxint=9)
      parameter(mxoz=725,mxaq=1)
      parameter(mxhill=20,mxtpts=25,mxrect=1000,mxcntr=21)
      parameter(mxprfz=50)
      parameter(mxent=10,mxntr=50,mxnw=5000)
      parameter(mxvalz=10)
      parameter(mxcoast=10,mxptcst=5000)
      parameter(mxbndry=10,mxptbdy=5000)
      parameter(mxmetdat=366, mxemdat=12)
      parameter(mxmetsav=2)
      parameter(mxsg=30)
      parameter(io3=3,io4=4,io5=1,io6=2,io7=7,io8=8,io9=9)
      parameter(io10=10,io11=11,io12=12,io15=15,io19=19)
      parameter(io20=20,io22=22,io23=23,io24=24)
      parameter(io25=25,io28=28,io29=29,io30=30,io31=31,io32=32)
      parameter(io35=35,io36=36,io37=37)
      parameter(iomesg=0)
      parameter(iox=99)
      parameter(iopt2=100)
      parameter(ioar2=iopt2+mxemdat)
      parameter(iovol=ioar2+mxemdat)

c --- Compute derived parameters
      parameter(mxbc=2*mxnx+2*mxny)
      parameter(mxnzp1=mxnz+1)
      parameter(mxvertp1=mxvert+1)
      parameter(mxnxy=mxnx*mxny)
      parameter(mxnxyg=mxnxg*mxnyg)
      parameter(mxgsp=mxnxg*mxnyg*mxspec)
      parameter(mxrsp=mxrec*mxspec)
      parameter(mxcsp=mxrect*mxspec)
      parameter(mx2=2*mxspec,mx5=5*mxspec,mx7=7*mxspec)
      parameter(mxp2=2+mxspec,mxp3=3+mxspec)
      parameter(mxp4=4+mxspec,mxp6=6+mxspec)
      parameter(mxp7=7+mxspec,mxp8=8+mxspec,mxp14=mxspec+14)
      parameter(mxpuf6=6*mxpuff)
      parameter(mxlev=mxprfz)
      parameter(mxprfp1=mxprfz+1)
      parameter(mxentp1=mxent+1)
      parameter(mxgrup=mxspec)
      parameter(mxq12=mxspec*(mxpt1+mxarea)*2)
      parameter(mxspar=mxspec*mxarea,mxspln=mxspec*mxlines)
      parameter(mxsppt1=mxspec*mxpt1,mxspvl=mxspec*mxvol)
      parameter(mxspbc=mxspec*mxbc)
```

```
c --- Specify parameters for sizing GUI
      parameter(mxavar=1)
      parameter(mxlvar=1)
      parameter(mxpvar=1)
      parameter(mxvvar=1)

c --- GENERAL PARAMETER definitions:
c        MXPUFF - Maximum number of active puffs allowed on the
c                 computational grid at one time
c        MXSLUG - Maximum number of active slugs allowed on the
c                 computational grid at one time (can be set to
c                 one if the slug option is not used)
c        MXSPEC - Maximum number of chemical species.  N.B.: Changes
c                 to MXSPEC may also require code changes to BLOCK DATA
c                 and READCF.
c        MXGRUP - Maximum number of Species-Groups.  Results for grouped
c                 species are added together and reported using the
c                 name of the group, rather than the name of one of the
c                 species in the group. (MXGRUP = MXSPEC since specie
c                 names are used as group names whenever group names are
c                 not provided)
c          MXNX - Maximum number of METEOROLOGICAL grid cells in
c                 the X direction
c          MXNY - Maximum number of METEOROLOGICAL grid cells in
c                 the Y direction
c          MXNZ - Maximum number of vertical layers in
c                 the METEOROLOGICAL grid
c         MXNXG - Maximum number of SAMPLING grid cells in
c                 the X direction
c         MXNYG - Maximum number of SAMPLING grid cells in
c                 the Y direction
c         MXREC - Maximum number of non-gridded receptors
c        MXRFOG - Maximum number of distances used when MFOG=1
c                 NOTE:  There are NPT1+NPT2 receptor 'trails', with
c                        MXRFOG receptors on each, so
c                        MXREC >= (NPT1+NPT2)*MXRFOG
c          MXSS - Maximum number of surface meteorological stations
c                 in the CALMET data
c          MXUS - Maximum number of upper air stations in the CALMET
c                 data
c          MXPS - Maximum number of precipitation stations in the
c                 CALMET data
c          MXBC - Maximum number of sources used to represent boundary
c                 conditions (inlux of background mass);  source
c                 segments span the computational domain perimeter
c         MXPT1 - Maximum number of point sources with constant
c                 emission parameters
c         MXPT2 - Maximum number of point sources with time-varying
c                 emission parameters
c        MXAREA - Maximum number of polygon area sources with constant
c                 emission parameters (i.e., non-gridded area sources)
c        MXVERT - Maximum number of vertices in polygon area source
c        MXLINES- Maximum number of line sources
c        MXLNGRP- Maximum number of groups of line sources
c         MXVOL - Maximum number of volume sources
c        MXRISE - Maximum number of points in computed plume rise
c                 tabulation for buoyant area and line sources
c        MXPDEP - Maximum number of particle species dry deposited
c         MXINT - Maximum number of particle size intervals used
c                 in defining mass-weighted deposition velocities
c          MXOZ - Maximum number of ozone data stations (for use in the
c                 chemistry module)
```

```
c          MXAQ - Maximum number of Air Quality data stations (e.g.
c                 H2O2 data stations for aqueous chemistry module)
c        MXHILL - Maximum number of subgrid-scale (CTSG) terrain
c                 features
c        MXTPTS - Maximum number of points used to obtain flow
c                 factors along the trajectory of a puff over the hill
c        MXRECT - Maximum number of complex terrain (CTSG) receptors
c        MXCNTR - Maximum number of hill height contours (CTDM ellipses)
c        MXPRFZ - Maximum number of vertical levels of met. data in
c                 CTDM PROFILE file
c         MXLEV - Maximum number of vertical levels of met. data
c                 allowed in the CTSG module (set to MXPRFZ in the
c                 current implementation of CALPUFF)
c         MXENT - Maximum number of perturbed entrainment coefficients
c                 entered
c         MXNTR - Maximum number of downwind distances for which
c                 numerical plume rise will be reported
c          MXNW - Maximum number of downwind distances for numerical
c                 plume rise integration (should be set equal to
c                 SLAST/DS)
c        MXVALZ - Maximum number of heights above ground at which valley
c                 widths are found for each grid cell
c       MXCOAST - Maximum number of coasts provided in COASTLN.DAT file
c       MXPTCST - Maximum number of points used to store all coastlines
c       MXBNDRY - Maximum number of boundaries provided in FLUXBDY.DAT
c       MXPTBDY - Maximum number of points used to store all boundaries
c      MXMETDAT - Maximum number of CALMET.DAT files used in run
c       MXEMDAT - Maximum number of variable emissions files (each type)
c      MXMETSAV - Maximum number of met periods for which source tables
c                 (e.g. numerical rise) are saved
c         MXQ12 - Maximum number of groups of 12 emission rate scaling
c                 factors.  Factors come in groups of 12,24,36, or 96.
c                 These are specified for source-species combinations,
c                 but not all combinations will be filled.  Default
c                 value of MXQ12 assumes that no more than 24 factors
c                 are provided for each source-species combination for
c                 point and area sources.

c --- CONTROL FILE READER definitions:
c          MXSG - Maximum number of input groups in control file

c --- FORTRAN I/O unit numbers:
c           IO3 - Restart file (RESTARTB.DAT)     - input  - unformatted
c           IO4 - Restart file (RESTARTE.DAT)     - output - unformatted
c           IO5 - Control file (CALPUFF.INP)      - input  - formatted
c           IO6 - List file (CALPUFF.LST)         - output - formatted
c           IO7 - Meteorological data file        - input  - unformatted
c                 (CALMET.DAT)
c           IO8 - Concentration output file       - output - unformatted
c                 (CONC.DAT)
c           IO9 - Dry flux output file            - output - unformatted
c                 (DFLX.DAT)
c          IO10 - Wet flux output file            - output - unformatted
c                 (WFLX.DAT)
c          IO11 - Visibility output file          - output - unformatted
c                 (VISB.DAT)
c          IO12 - Fog plume data output file      - output - unformatted
c                 (FOG.DAT)
c          IO15 - Boundary Condition file         - input  - unformatted
c                 (BCON.DAT)
c          IO19 - Buoyant line sources file       - input  - free format
c                 (LNEMARB.DAT) with arbitrarily
c                 varying location & emissions
```

```
c          IO20 - User-specified deposition     - input   - formatted
c                 velocities (VD.DAT)
c          IO22 - Hourly ozone monitoring data  - input   - formatted
c                 (OZONE.DAT)
c          IO23 - Hourly H2O2 monitoring data   - input   - formatted
c                 (H2O2.DAT)
c          IO24 - User-specified chemical       - input   - formatted
c                 transformation rates
c                 (CHEM.DAT)
c          IO25 - User-specified coast line(s)  - input   - free format
c                 for sub-grid TIBL module
c                 (COASTLN.DAT)
c          IO28 - CTSG hill specifications from - input   - formatted
c                 CTDM terrain processor
c                 (HILL.DAT)
c          IO29 - CTSG receptor specifications  - input   - formatted
c                 from CTDM receptor generator
c                 (RECS.DAT)
c          IO30 - Tracking puff/slug data       - output  - formatted
c                 (DEBUG.DAT)
c          IO31 - CTDM "tower" data             - input   - formatted
c                 (PROFILE.DAT)
c          IO32 - CTDM surface layer parameters - input   - formatted
c                 (SURFACE.DAT)
c          IO35 - User-specified boundary lines(s)- input- free format
c                 for mass flux calculations
c                 (FLUXBDY.DAT)
c          IO36 - Mass flux data                - output  - formatted
c                 (MASSFLX.DAT)
c          IO37 - Mass balance data             - output  - formatted
c                 (MASSBAL.DAT)
c         IOPT2 - 1st Pt. source emissions file - input   - unformatted
c                 (PTEMARB.DAT) with arbitrarily            or free fmt
c                 varying point source emissions
c         IOAR2 - 1st Buoyant area sources file - input   - free format
c                 (BAEMARB.DAT) with arbitrarily
c                 varying location & emissions
c         IOVOL - 1st Volume source file        - input   - unformatted
c                 (VOLEMARB.DAT) with arbitrarily           of free fmt
c                 varying location & emissions
c        IOMESG - Fortran unit number for screen- output - formatted
c                 output (NOTE: This unit is
c                 NOT opened -- it must be a
c                 preconnected unit to the screen
c                 -- Screen output can be suppressed
c                 by the input "IMESG" in the
c                 control file)
c           IOX - Fortran unit number for      - scratch - formatted
c                 temporary file of "doc" records
c                 written to header of output files

c --- GUI memory control parameters:  variable emissions scaling factors
c     for areas, lines, points, and volumes require much memory in GUI.
c     To reduce GUI memory requirement, set one or more of the
c     following parameters to ZERO when such scaling is not required.
c     These parameters have no effect on CALPUFF, but are read by the
c     GUI at execution time.
c        MXAVAR - Using scaled area sources?   (1:yes, 0:no)
c        MXLVAR - Using scaled line sources?   (1:yes, 0:no)
c        MXPVAR - Using scaled point sources?  (1:yes, 0:no)
c        MXVVAR - Using scaled volume sources? (1:yes, 0:no)
```

```
c-----------------------------------------------------------------------
c     POSTUTIL PARAMETERS
c-----------------------------------------------------------------------

c --- Specify model version
      character*12 mver, mlevel
      parameter(mver='1.3',mlevel='030402')

c --- Specify application size
      PARAMETER(mxtpd=24)
      PARAMETER(mxssg=10)
      PARAMETER(mxgx=388)
      PARAMETER(mxgy=265)
      PARAMETER(mxgrec=mxgx*mxgy)
      PARAMETER(mxnx=mxgx,mxny=mxgy,mxnxy=mxgrec)
      PARAMETER(mxdrec=10000)
      PARAMETER(mxctrec=1000)
      PARAMETER(mxnz=16,mxspec=20)
      PARAMETER(mxsplv=mxspec)
      PARAMETER(mxnzp1=mxnz+1)
      PARAMETER(mxss=350,mxus=99,mxps=700,mxprfz=50)
      PARAMETER(mxfile=366)
      PARAMETER(icols=25)
      PARAMETER(in1=10,in2=5,in3=9,in4=4)
      PARAMETER(io7=in4)
      PARAMETER(io1=7,io2=8,io6=6)
      PARAMETER(iox=99)
      parameter(mxsg=3)

c-----------------------------------------------------------------------
c     DEFINITIONS       [i]=integer     [r]=real        [a]=array
c-----------------------------------------------------------------------
c mxtpd          maximum number of time periods (CALPUFF files)      [i]
c                (NOT ACTIVE)
c mxssg          maximum number of source-species groups             [i]
c                in CALPUFF output files
c                (NOT ACTIVE)
c mxgx           maximum number gridded receptors along "x"          [i]
c mxgy           maximum number gridded receptors along "y"          [i]
c mxgrec         product mxgx*mxgy                                   [i]
c mxnx           maximum number of met grid cells along "x"          [i]
c mxny           maximum number of met grid cells along "y"          [i]
c mxnxy          product mxnx*mxny                                   [i]
c mxdrec         maximum number of discrete receptors                [i]
c mxctrec        maximum number of complex terrain (CTSG) receptors  [i]
c mxnz           maximum number of levels                            [i]
c mxnzp1         maximum number of levels + 1                        [i]
c mxspec         maximum number of species                           [i]
c mxsplv         max number of chemical species * max number levels  [i]
c mxss           maximum number of surface met stations              [i]
c mxus           maximum number of upper air met stations            [i]
c mxps           maximum number of precipitation stations            [i]
c mxprfz         maximum number of levels in vertical profile        [i]
c mxfile         max number of CALPUFF data files processed          [i]
c icols          number of columns in gridded integer output         [i]
c in1            unit number for input data file (CALPUFF.DAT)       [i]
c                - this is for the first file in the list, the
c                - subsequent files are incremented from in1
c                - MAKE CERTAIN NO OTHER UNIT #s EXCEED in1
c in2            unit number for control file input (POSTUTIL.INP)   [i]
c in3            unit number for input file of RH data (CALPUFF.VIS) [i]
c in4 (io7)      unit number for complete met. input file (MET.DAT)  [i]
c io1            unit number for output list file (POSTUTIL.LST)     [i]
```

```
c io2          unit number for output data file (MODEL.DAT)         [i]
c io6          unit number for screen output (error messages)       [i]
c iox          unit number for control file images (scratch)        [i]
c-----------------------------------------------------------------------

c --- CONTROL FILE READER definitions:
c          MXSG - Maximum number of input groups in control file
```

```
c----------------------------------------------------------------------
c     CALPOST PARAMETERS
c----------------------------------------------------------------------

c --- Specify model version
      character*12 mver, mlevel
      parameter(mver='5.51',mlevel='030709')

c --- Specify application size
      PARAMETER(mxgx=388)
      PARAMETER(mxgy=265)
      PARAMETER(mxgrec=mxgx*mxgy)
      PARAMETER(mxdrec=10000, mxring=40)
      PARAMETER(mxctrec=1000)
      PARAMETER(mxtser=30)
      PARAMETER(mxnz=1,mxspec=20)
      PARAMETER(mxsplv=mxnz*mxspec)
      PARAMETER(mxss=350)
      PARAMETER(mxwsta=30)
      PARAMETER(mxday=366)
      PARAMETER(mxwin=10)
      PARAMETER(mxrnk=10,mxtop=4)
      PARAMETER(icols=25)
      PARAMETER(in1=4,in2=5,in3=9,in4=18,in5=19)
      PARAMETER(io1=8,io6=6)
      PARAMETER(iot1=21,iot3=22,iot24=23,iotn=24)
      PARAMETER(mapu=11)
      PARAMETER(iox1=12,iox2=13,iox3=14,iox4=15)
      PARAMETER(iowx1=31,iowx2=32,iohrv=33)
      parameter(mxsg=4)

c----------------------------------------------------------------------
c     DEFINITIONS       [i]=integer     [r]=real        [a]=array
c----------------------------------------------------------------------
c mxgx          maximum number gridded receptors along "x"            [i]
c mxgy          maximum number gridded receptors along "y"            [i]
c mxgrec        product mxgx*mxgy                                     [i]
c mxdrec        maximum number of discrete receptors                  [i]
c mxring        maximum number of discrete receptor "rings"           [i]
c mxctrec       maximum number of complex terrain (CTSG) receptors    [i]
c mxtser        maximum number of receptors in timeseries output      [i]
c mxnz          maximum number of levels                              [i]
c mxspec        maximum number of species                             [i]
c mxsplv        max number of chemical species * max number levels    [i]
c mxss          max number of surface stations in CALMET/CALPUFF      [i]
c mxwsta        max number of weather stations in VSRN.DAT (DATSAV3) [i]
c mxday         max number of days in run for violation option        [i]
c mxwin         max number of days in window (for violation search)  [i]
c mxrnk         max rank of top-ranked concentrations                 [i]
c mxtop         max number of top-ranked concentrations               [i]
c icols         number of columns in gridded integer output           [i]
c in1           unit number for "concentration" input file            [i]
c in2           unit number for control file input                    [i]
c in3           unit number for input file of RH data                 [i]
c in4           unit number for input file of background data         [i]
c in5           unit number for input file of visual range data       [i]
c io1           unit number for output list file                      [i]
c io6           unit number for standard output (error messages)      [i]
c iot1          unit number for timeseries file (1hr avg)             [i]
c iot3          unit number for timeseries file (3hr avg)             [i]
c iot24         unit number for timeseries file (24hr avg)            [i]
c iotn          unit number for timeseries file (Nhr avg)             [i]
c mapu          unit number for current plot-file                     [i]
```

```
c iox1          unit number for scratch file (extinction summary)    [i]
c iox2          unit number for scratch file (deciview summary)      [i]
c iox3          unit number for scratch file (run length extinction) [i]
c iox4          unit number for scratch file (run length deciview)   [i]
c iowx1         unit number for scratch file (weather data image 1)  [i]
c               (saved as DEBUG.WX1 when LDEBUG=T)
c iowx2         unit number for scratch file (weather data image 2)  [i]
c               (saved as DEBUG.WX2 when LDEBUG=T)
c iohrv         unit number for hourly visibility calculation        [i]
c               details (saved as DEBUG.HRV when LDEBUG=T)
c----------------------------------------------------------------------

c --- CONTROL FILE READER definitions:
c          MXSG - Maximum number of input groups in control file
```

APPENDIX D
LDEQ SUBMITTALS

The files submitted electronically with this report are organized into the directories listed in Table D-1. The files are listed in Tables D-2 through D-4 and include input and output files from all models and pre-processors. The submissions do not include CALMM5 files, files containing observations from the weather stations listed in Table 3-3, CALMET.DAT files output by CALMET, or VISB.DAT files output by CALPUFF, since these files together would require over 70 GB of storage space. In Tables D-1 through D-4, *yyyy* or *yy* stand for one of the years 2001-2003 and numbers in square brackets ([*1-3*]) stand for a sequence of numbers (*1, 2, 3*).

Table D-1
Directory Structure

Directory	Contents
GeoData	Files for geophysical data pre-processors (see Table D-2)
MetData	Files for meteorological data pre-processors (see Table D-3)
yyyy\	CALMET files for year *yyyy*
yyyy\bret	CALPUFF and POSTUTIL files for modeling all units for year *yyyy*
yyyy\bret\fullyear	CALPOST files for modeling all units for year *yyyy*
yyyy\contrib	CALPUFF and POSTUTIL files for contribution analysis for year *yyyy*
yyyy\contrib\results	CALPOST files for contribution analysis for year *yyyy*
yyyy\post	CALPUFF and POSTUTIL files for post-control modeling for year *yyyy*
yyyy\post\results	CALPOST files for post-control modeling for year *yyyy*

Table D-2
Files in GeoData Directory

Filename	Contents
Ctgproc[*0-4*].inp	Land use pre-processor input file
CTGPROC[*0-4*].LST	Land use pre-processor runtime information file
LANDUSE[*0-3*].DAT	Land use pre-processor intermediate output files
LANDUSE.DAT	Land use pre-processor output file from final run
TERREL.INP	Terrain pre-processor input file
terrel.lst	Terrain pre-processor runtime information file
terrel.dat	Terrain pre-processor output file
MAKEGEO.INP	Geophysical data pre-processor input file
MAKEGEO.LST	Geophysical data pre-processor runtime information file
MAKEGEO.DAT	Geophysical data pre-processor output file

For the meteorological data pre-processors, a single input file has been included. The files for other years have the same processing options, but different starting and ending dates.

Table D-3
Files in MetData Directory

Filename	Contents
ozone*yyyy*.dat	Ozone concentration files for year *yyyy*
SMERGE.INP	Surface data pre-processor input file
smerge*.lst	Surface data pre-processor runtime information files for various surface stations
surf*yy*.dat	Surface data pre-processor output file for year *yy*
READ62.INP	Upper air data pre-processor input file
Original 53813_*yy*.UA	Upper air output file before substitutions for year *yy*
53813_*yy*.UA	Upper air output file after substitutions for year *yy*
53813_*yy*.LST	Upper air data pre-processor runtime information file for year *yy*
PMERGE.INP	Precipitation data pre-processor input file
PMERGE*YY*.LST	Precipitation data pre-processor runtime information file for year *yy*
PRECIP*YY*.DAT	Precipitation data pre-processor output file for year *yy*

When performing contribution analysis, the CALPUFF input file for each year was split into 27 different files (i.e., one file for each BART-eligible unit). The unit was assigned a number corresponding to its order within the original input file. POSTUTIL and CALPOST input files were then created to process and evaluate visibility impacts for individual units.

Table D-4
Files Generated by Models

Filename	Directory	Contents
calmet*yyyy*[*01-12*].inp	*yyyy*	CALMET input file for a single month in year *yyyy*
calmet*yyyy*[*01-12*].lst	*yyyy*	CALMET runtime information file for a single month in year *yyyy*
CALPUFF.INP	*yyyy*\bret	CALPUFF input file for modeling all units for year *yyyy*
CALPUFF.LST	*yyyy*\bret	CALPUFF runtime information file for modeling all units for year *yyyy*
CONC.DAT	*yyyy*\bret	CALPUFF concentration output file for year *yyyy*
DFLX.DAT	*yyyy*\bret	CALPUFF dry flux output file for year *yyyy*
WFLX.DAT	*yyyy*\bret	CALPUFF wet flux output file for year *yyyy*
POSTUTIL.INP	*yyyy*\bret	POSTUTIL input file for modeling all units for year *yyyy*

Table D-4
(continued)

postutil.lst	*yyyy*\bret	POSTUTIL runtime information file for modeling all units for year *yyyy*
postutilconcout.dat	*yyyy*\bret	POSTUTIL output file for year *yyyy*
CALPOST.INP	*yyyy*\bret\fullyear	CALPOST input file for modeling all units for year *yyyy*
calpost.lst	*yyyy*\bret\fullyear	CALPOST runtime information file for modeling all units for year *yyyy*
v24v*yyyy*.dat	*yyyy*\bret\fullyear	CALPOST visibility output file for year *yyyy*
CALPUFF[*1-27*].INP	*yyyy*\contrib	CALPUFF input file for year *yyyy* for a single unit
CALPUFF[*1-27*].LST	*yyyy*\contrib	CALPUFF runtime information file for year *yyyy* for a single unit
CONC[*1-27*].DAT	*yyyy*\contrib	CALPUFF concentration output file for year *yyyy* for a single unit
DFLX[*1-27*].DAT	*yyyy*\contrib	CALPUFF dry flux output file for year *yyyy* for a single unit
WFLX[*1-27*].DAT	*yyyy*\contrib	CALPUFF wet flux output file for year *yyyy* for a single unit
POSTUTIL[*1-27*].INP	*yyyy*\contrib	POSTUTIL input file for year *yyyy* for a single unit
postutil[*1-27*].lst	*yyyy*\contrib	POSTUTIL runtime information file for year *yyyy* for a single unit
postutilconcout[*1-27*].dat	*yyyy*\contrib	POSTUTIL output file for year *yyyy* for a single unit
CALPOST[*1-27*].INP	*yyyy*\contrib\results	CALPOST input file for year *yyyy* for a single unit
calpost[*1-27*].lst	*yyyy*\contrib\results	CALPOST runtime information file for year *yyyy* for a single unit
v24v*yy*[*1-27*].dat	*yyyy*\contrib\results	CALPOST visibility output file for year *yyyy* for a single unit

The **post** directory contains modeling files for both all-unit and contribution analyses. The files are named similarly to those in the **bret** and **contrib** directories, except that the POSTUTIL input file for modeling all units is named POSTUTIL_ALL.INP.

The files are submitted on three compact disks (CDs). The first CD contains the GeoData, MetData, and 2001 directories. The second CD contains the 2002 directory with all files pertinent to 2002 impacts modeling. The third CD contains the 2003 directory.

APPENDIX E
UPPER AIR DATA SUBSTITUTIONS

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana

Upper Air Data Substitutions
Slidell, LA
WBAN Station 53813

Date	Error	Substitution
January 1, 2001, hour 0	Missing sounding	Filled with data for January 2, 2001, hour 0
January 17, 2001, hour 0	Missing sounding	Filled with data for January 16, 2001, hour 0
January 25, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 283.6 Kelvin at bottom of sounding
January 30, 2001, hour 0	Missing sounding	Filled with data for January 29, 2001, hour 0
February 5, 2001, hour 0	Data at bottom of sounding is missing	Replaced with data for February 4, 2001, hour 0
February 26, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 291.5 Kelvin at bottom of sounding
March 14, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 294.9 Kelvin at bottom of sounding
March 30, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 293.1 Kelvin at bottom of sounding
April 13, 2001, hour 0	Missing sounding	Filled with data for April 12, 2001, hour 0
April 17, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 297.2 Kelvin at bottom of sounding
April 19, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 289.6 Kelvin at bottom of sounding
April 22, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 295.9 Kelvin at bottom of sounding
April 23, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 296.6 Kelvin at bottom of sounding
April 26, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 294.4 Kelvin at bottom of sounding
April 27, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 297.2 Kelvin at bottom of sounding
May 9, 2001, hour 0	Missing sounding	Filled with data for May 8, 2001, hour 0
May 16, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 302.2 Kelvin at bottom of sounding
May 25, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 302.2 Kelvin at bottom of sounding
June 2, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 302.8 Kelvin at bottom of sounding
June 17, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 302.9 Kelvin at bottom of sounding
June 19, 2001, hour 12	Top of sounding is below 500.0 mb	Replaced with data for June 18, 2001, hour 12
June 20, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 298.6 Kelvin at bottom of sounding
July 9, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 303.4 Kelvin at bottom of sounding
July 14, 2001, hour 0	Data at bottom of sounding is missing	Temperature set to 296.6 Kelvin at bottom of sounding
August 10, 2001, hour 12	Top of sounding is below 500.0 mb	Replaced with data for August 9, 2001, hour 12
September 1, 2001, hour 0	Missing sounding	Filled with data for August 31, 2001, hour 0
October 14, 2001, hour 0	Top of sounding is below 500.0 mb	Replaced with data for October 13, 2001, hour 0

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana

Upper Air Data Substitutions
Slidell, LA
WBAN Station 53813

Date	Error	Substitution
March 5, 2002, hour 0	Data at bottom of sounding is missing	Replaced with data for March 4, 2002, hour 0
March 10, 2002, hour 0	Missing sounding	Filled with data for March 9, 2002, hour 0
April 3, 2002, hour 12	Missing sounding	Filled with data for April 2, 2002, hour 12
June 28, 2002, hour 0	Missing sounding	Filled with data for June 27, 2002, hour 0
July 22, 2002, hour 0	Missing sounding	Filled with data for July 21, 2002, hour 0
July 23, 2002, hour 12	Data at bottom of sounding is missing	Replaced with data for July 22, 2002, hour 12
August 3, 2002, hour 0	Missing sounding	Filled with data for August 2, 2002, hour 0
September 26, 2002, hour 12	Data at bottom of sounding is missing	Replaced with data for September 25, 2002, hour 12
November 11, 2002, hour 0	Data at bottom of sounding is missing	Replaced with data for November 10, 2002, hour 0
February 10, 2003, hour 12	Elevation is decreasing with height	Replaced with data for February 9, 2003, hour 12
February 21, 2003, hour 0	Missing sounding	Filled with data for February 20, 2003, hour 0

APPENDIX F
VISIBILITY IMPACTS

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana
Visibility Impact Analysis

Breton Class I Area		
2001 delta-dv	2002 delta-dv	2003 delta-dv
4.234	6.278	4.926
3.650	5.355	4.543
3.396	4.962	4.488
3.324	4.650	4.119
2.995	4.543	4.042
2.689	3.610	4.021
2.358	3.437	3.791
2.344	3.116	3.610

The 22nd highest value over the three-year period is 2.689 delta-dv, which is above the 0.5 delta-dv threshold.

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana
Visibility Impact Summary

EPN	Description	98^{th} Percentile Delta-DV Value
1291-H-2/3	FCCU Light/Heavy Feed Heater	0.013
301-B-2A	CO Boiler	**0.530**
301-B-2B	CO Boiler	**0.529**
292-H-1	Light Distillate Gulfiner Reactor Heater	0.003
292-H-2	Light Distillate Gulfiner Stabilizer Heater	0.005
191-H-1	Crude Charge Heater	0.264
191-H-2	Vacuum Charge Heater	0.062
406-D-15	Product Dock No.1 MVR Loading	0.006
406-D-16	Product Dock No.2 MVR Loading	0.006
891-H-1	Delayed Coker Charge Heater	0.039
891-CP	Coke Transfer and Storage	0.002
491-H-1	Alkylation Isostripper Reboiler	0.034
491-H-2	Alkylation Depropanizer Reboiler	0.040
100-H-1	Coker Charge Storage Heater	0.001
293-H-1	Heavy Distillate Gulfiner Reactor Feed Heater	0.007
293-H-2	Heavy Distillate Gulfiner Stabilizer Reboiler	0.009
1391-H-1	Catalytic Reformer Feed Heater No. 1	0.024
1391-H-2/3	Catalytic Reformer Feed Heater No. 2 & 3	0.022
1391-H-4	Depentanizer Reboiler	0.055
1391-H-5	Dry Reactivation Heater	0.001
1791-H-1	Reformate Splitter Reboiler	0.021
1792-H-1	Hydrodealkylation Charge Heater	0.012
291-H-1	Naphiner Reactor Feed Heater	0.021
291-H-2	Naphiner Deisohexanizer Reboiler	0.017
303-R-1	Cooling Water Tower No. 1	0.076
308F-D-1	Low Pressure Flare	**1.033**
308F-D-2	High Pressure Flare	0.359

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana
Post Control Visibility Impact Analysis

Breton Class I Area		
2001 delta-dv	2002 delta-dv	2003 delta-dv
2.162	3.107	2.975
2.106	3.034	2.178
1.833	2.296	2.081
1.805	2.268	2.071
1.483	1.942	1.827
1.468	1.676	1.748
1.451	**1.444**	1.684
1.301	1.326	1.664

The 22nd highest value over the three-year period is 1.444 delta-dv, which is above the 0.5 delta-dv threshold.

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana
Visibility Impact Summary

EPN	Description	98th Percentile Delta-DV Value
1291-H-2/3	FCCU Light/Heavy Feed Heater	0.013
301-B-2A	CO Boiler	**0.530**
301-B-2B	CO Boiler	**0.529**
292-H-1	Light Distillate Gulfiner Reactor Heater	0.003
292-H-2	Light Distillate Gulfiner Stabilizer Heater	0.005
191-H-1	Crude Charge Heater	0.264
191-H-2	Vacuum Charge Heater	0.062
406-D-15	Product Dock No.1 MVR Loading	0.006
406-D-16	Product Dock No.2 MVR Loading	0.006
891-H-1	Delayed Coker Charge Heater	0.039
891-CP	Coke Transfer and Storage	0.002
491-H-1	Alkylation Isostripper Reboiler	0.034
491-H-2	Alkylation Depropanizer Reboiler	0.040
100-H-1	Coker Charge Storage Heater	0.001
293-H-1	Heavy Distillate Gulfiner Reactor Feed Heater	0.007
293-H-2	Heavy Distillate Gulfiner Stabilizer Reboiler	0.009
1391-H-1	Catalytic Reformer Feed Heater No. 1	0.024
1391-H-2/3	Catalytic Reformer Feed Heater No. 2 & 3	0.022
1391-H-4	Depentanizer Reboiler	0.055
1391-H-5	Dry Reactivation Heater	0.001
1791-H-1	Reformate Splitter Reboiler	0.021
1792-H-1	Hydrodealkylation Charge Heater	0.012
291-H-1	Naphiner Reactor Feed Heater	0.021
291-H-2	Naphiner Deisohexanizer Reboiler	0.017
303-R-1	Cooling Water Tower No. 1	0.076
308F-D-1	Low Pressure Flare	**1.033**
308F-D-2	High Pressure Flare	0.359

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana
Post Control Visibility Impact Summary

EPN	Description	98th Percentile Delta-DV Value
301-B-2A	CO Boiler	0.338
301-B-2B	CO Boiler	0.342
308F-D-1	Low Pressure Flare	0.032
308F-D-2	High Pressure Flare	0.037

APPENDIX G
MODELING PROTOCOL AND APPROVAL

ATTACHMENT II

SAGE
ENVIRONMENTAL CONSULTING

ConocoPhillips

Revised BART Refined Modeling Protocol

Alliance Refinery
Belle Chasse, LA

April 2007

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SECTION 1
INTRODUCTION

1.1 Objectives

The objective of the refined Best Available Retrofit Technology (BART) modeling is to determine the potential visibility impairment impact of sulfur dioxide (SO_2), nitrogen oxides (NO_X), and inhalable particulate matter (PM_{10}) emissions from the Alliance Refinery operated by ConocoPhillips in Belle Chasse, LA on the Breton Wilderness Class I area. The purpose of refined modeling is to show that the visibility impact of the Alliance Refinery on the Breton Wilderness Class I area is below the BART threshold. If this cannot be demonstrated, then refined modeling will be used in a BART engineering analysis.

1.2 Guidances Used

Several guidances were used to develop this protocol. The Central Regional Air Planning Association's *CENRAP BART Modeling Guidelines*[1] specified the requirements of a refined modeling protocol and the years to model. The receptors for the Breton Wilderness area were obtained from the National Park Service website. Tables 5 and 6 of the *BART Modeling Protocol* published by the Louisiana Department of Environmental Quality (LDEQ) in February 2007 list relative humidity correction factors and annual natural levels of aerosol used to compute visibility. Two other guidances from the LDEQ were used to determine modeling requirements for Louisiana. The "Regional Haze Preliminary Plan" document identifies 0.5 deciviews as the visibility threshold, and the "BART Determination Process" document specifies Louisiana's requirements for a source to be subject to BART.

1.3 Source Impact Evaluation Criteria

Refined modeling will be performed for the years 2001-2003, as required by Central Regional Air Planning Association (CENRAP). The result of modeling will be a measure of visibility conditions at the Breton Wilderness Class I area. The 98th percentile modeled value[2] will be compared to the natural visibility conditions for the area. The impact will depend on the difference between the modeled and natural visibility, measured in deciviews (dv). If the difference is less than 0.5 dv, the Alliance Refinery does not impact visibility at the Breton Wilderness Class I area. It is then exempt from further stages in the BART process. If the difference is greater than or equal to 0.5 dv, the Alliance Refinery is considered to contribute to visibility impairment. In this case, additional modeling will be

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[1] Dennis McNally, T. W. Tesche, and George Schewe, Alpine Geophysics, LLC. *CENRAP BART Modeling Guidelines*. Ft. Wright, Kentucky: December 15, 2005.

[2] The *CENRAP BART Modeling Guidelines* document defines the 98th percentile modeled value as the "8th highest day annually at a receptor or 22nd highest over 3 years" (p. 2-5).

completed for individual BART-eligible units to evaluate the contribution of each unit to the visibility impairment. The culpability analysis will allow separating units subject to BART engineering analysis from units that do not significantly contribute to visibility impairment.

1.4 Class I Areas Evaluated

The visibility impacts will be evaluated for the Breton Wilderness Class I area. This area is located approximately 94 kilometers from Belle Chase, LA. The other three Class I Areas (Caney Creek in Arkansas, Sipsey Wilderness in Alabama, and St. Marks Wilderness in Florida) are located well beyond 500-km from the refinery. Results of screening modeling conducted by the LDEQ for Louisiana BART-eligible sources[3] demonstrated that the Alliance Refinery and other facilities in southeast Louisiana, as a group, do not adversely impact the Caney Creek Class I Area. Back tracking analysis conducted by Visibility Improvement State and Tribal Association of the Southeast (VISTAS) for the 20% worst days for all areas located within the VISTAS domain[4] indicates that during only one day puffs traveling from southeast Louisiana can impact either Sipsey or St. Marks wilderness areas. If impacts on the Breton Wilderness from the Alliance Refinery exceed the visibility impairment contribution level, the source will be subject to BART Engineering Analyses. If, however, Alliance Refinery BART-eligible units do not contribute to visibility impairment at the Breton Class I Area located less than 100 kilometers from the source, it is not likely that the source may contribute to visibility impairments at areas located at puff travel distances exceeding 500 km.

1.5 Modeling Team

Sage Environmental Consulting, L.P. (Sage Environmental) will provide the modeling for this project. Sage Environmental has comprehensive experience in various air dispersion modeling applications in the United States of America and world-wide. Sage Environmental provides full-service engineering and management consulting services in the areas of air permitting and compliance program development, atmospheric studies, infrastructure development, hazardous waste site investigation and remediation, air quality management, environmental assessment, permitting and compliance, pollution prevention, and environmental management systems.

Sage Environmental's air dispersion modeling team provides consulting services in the atmospheric sciences. The team specializes in non-steady-state modeling, photochemical modeling, dispersion model development, air quality permitting and licensing, modeling for accidental release, analysis of aerometric and emissions data, and regulatory consulting. The Sage Environmental's technical staff employs highly qualified scientists and consultants with exceptional depth and breadth of professional experience.

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[3] Louisiana Department of Environmental Quality (February 2007). *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana*, pp. 34-36.
[4] Brewer, Pat. *Weight of Evidence: Residence Time Analyses.* September 22, 2005.
http://www.vistas-sesarm.org/documents/VISTASJointWorkGroupMeeting09052005/7_Brewer_Residence%20 time_20050922.ppt

1.6 Submittals

The modeling results will be summarized in a modeling report to be submitted to the LDEQ. This report will include a textual description of all phases of the modeling analysis and tables containing the modeling results. The report will also include all input, output, and supplemental electronic files pertinent to the modeling analysis, as required by the LDEQ *BART Modeling Protocol.*[5]

[5] Louisiana Department of Environmental Quality (February 2007). *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana*, p. 15.

SECTION 2
MODELING METHODOLOGY

2.1 Model Selection

The model recommended by the LDEQ for BART refined modeling is CALPUFF, developed by Atmospheric Studies Group. Sage will use the EPA-approved versions of CALPUFF, CALMET and CALPOST in Table 2-1. Sage will also use version 2.34.1 of the Professional CALPUFF graphical user interface developed by BEE-Line Software. Three annual simulations will be done for the years 2001-2003.

Table 2-1
Proposed Versions of the Modeling Software

Program Name	Version	Released
CALMET	5.53a	July 16, 2004
CALPUFF	5.711a	July 16, 2004
CALPOST	5.51	July 9, 2003

2.2 CALMET Configuration and Specific Settings

When performing refined modeling for BART, Sage will use the following CALMET options. Default settings will be used unless noted in Section 3.2.

- No data will be used from overwater stations.
- Anemometer heights for surface stations will be set to 10 m.
- The values for the ZFACE option (cell face heights) will be set to 0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1000 m, 1200 m, 1500 m, 2000 m, 3000 m, and 4000 m.
- The value for the NZ option (number of vertical layers) will be set to 12.
- The value for the TERRAD option will be set to 25 km.
- The value for the R1 option will be set to 20 km.
- The value for the R2 option will be set to 50 km.
- The value for the RMAX1 option will be set to 100 km.
- The value for the RMAX2 option will be set to 200 km.
- The value for the RMAX3 option will be set to 300 km.

The CALMET processor contains overwater and overland boundary layer parameterizations allowing certain of the effects of water bodies on plume transport, dispersion, and deposition to be estimated. These effects include the abrupt changes that occur at a coastline of a major body of water.

Additional details are provided in Section 3.2.

2.3 CALPUFF Configuration and Specific Settings

When performing refined modeling for BART, Sage will use the following CALPUFF options. Default settings will be used unless noted in Sections 3.3 and 3.4.

- No puff splitting.
- No building downwash.
- No sub-grid scale complex terrain.
- Wet removal will be modeled.
- Dry deposition will be modeled.

The emission sources will be the BART-eligible units at the Alliance Refinery. A list of the sources and their release parameters is provided in Appendix A. See Section 3.4 for additional details.

2.4 CALPOST Configuration and Specific Settings

When performing refined modeling for BART, Sage will use the following CALPOST options. Default settings will be used unless noted in Section 3.5.

- Visibility processing.
- Method 6 for background light extinction.
- Sulfate and nitrate species included in computing total light extinction.
- Create file of daily delta-deciview.
- 24-hour averaging period.
- 98th percentile (22nd high value for the 3-year period) will be compared to the natural visibility conditions.

2.5 Domain Configuration and Receptors

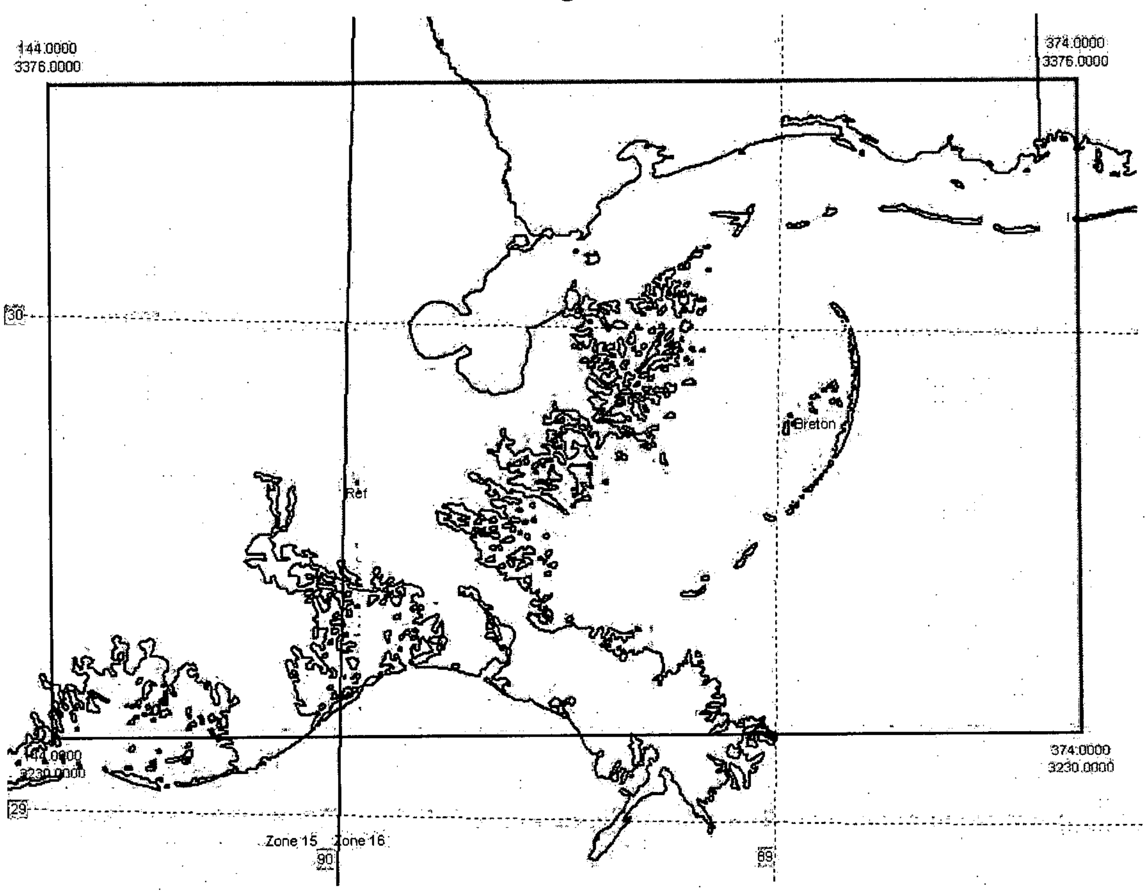
The modeling domain is depicted in Section 3.1. The receptors will be the set of Class I area receptors developed by the National Park Service. There will be 40 receptors covering the Breton Wilderness Class I area, spaced approximately 1 km from each other. When running CALPUFF, only the receptors for this Class I area will be included.

SECTION 3
MODEL INPUT DATA

3.1 Modeling Domain

The proposed modeling domain is depicted on Figure 3-1. Each grid cell will have the size 2 km by 2 km. The domain will be a rectangle that will include all emission sources, the Breton Wilderness Class I area, and a buffer extending at least 50 km in all directions from the boundaries of the Alliance Refinery and Class I area.

Figure 3-1
Modeling Domain



CALPUFF has two domains, the meteorological domain and the computational domain. The meteorological domain determines the extent of meteorological data processed by CALMET.

The computational domain determines how far CALPUFF tracks puffs and their concentrations. The computational domain can be a subset of the meteorological domain. For the refined BART modeling, the two domains will be the same.

3.2 Meteorological Data

The meteorological preprocessor for CALPUFF is called CALMET. Sage will develop CALMET data files for the years 2001-2003. Prognostic data for 2001 (36 km EPA), 2002 (12 km WRAP) and 2003 (36 km MRPO) will be used for developing the Initial Guess Wind Fields in the CALMET model. The CALMM5 extraction from the prognostic data was supplied by BEE-Line Software. The 2001 and 2003 data cover the conterminous United States at a spacing of 36 kilometers. The 2002 data cover the western portion of the conterminous United States at a spacing of 12 kilometers. In addition to the CALMM5 data, observations will be used to develop the Step 2 Wind Fields, including surface, upper air, and precipitation weather observations from the stations listed in Table 3-1.

Table 3-1
WBAN Stations Proposed for CALMET Processing

WBAN ID	Station Name	State	Type of Data
12884	Boothville	LA	Surface
12916	New Orleans International Airport	LA	Surface, Precipitation
12936	Patterson	LA	Surface
12968	Salt Point	LA	Surface
13820	Keesler	MS	Surface
13838	Mobile	AL	Surface
13894	Mobile Airport	AL	Surface, Precipitation
13943	New Orleans	LA	Surface
13970	Baton Rouge Ryan Airport	LA	Surface
53813	Slidell	LA	Surface, Upper Air
53858	Pascagoula	MS	Surface
93874	Gulfport-Biloxi	MS	Surface
Not available	Dauphin Island #2	AL	Surface, Precipitation
Not available	Southwest Pass	LA	Surface
Not available	LSU Citrus Research Station	LA	Precipitation
Not available	New Orleans Audubon	LA	Precipitation
Not available	Hammond	LA	Precipitation
Not available	Slidell WSFO	LA	Precipitation
Not available	Biloxi	MS	Precipitation
Not available	Pascagoula	MS	Precipitation
Not available	Saucier Exp Forest	MS	Precipitation

When developing CALMET data files, Sage will change the following default options that determine processing of wind fields. The option IWFCOD will be set to 1 (one) to use

CALMET's diagnostic wind module. The option IPROG will be set to 14 to utilize CALMM5 data files in developing the initial guess field. The BIAS option will be an array of twelve zeroes, corresponding to the number of vertical layers. The CALMM5 files which will be used in the modeling will be prepared by BEE-Line Software.

3.2.1 Land Use and Terrain Data

CALMET requires land use and terrain data in addition to weather observations. Sage will obtain both sets of data for the modeling domain addressed in Section 3.1. For terrain, Sage will use the 3-arc-second data included in the Professional CALPUFF interface, originally obtained from the US Geological Survey (USGS). For land use, Sage will obtain the 250K LULC data in CTG format from USGS. The USGS data set will be supplemented with land use data for the continent of North America (available from the CALPUFF website[6]) to account for the lack of USGS data for the Gulf of Mexico.

3.2.2 Procedures for Missing Meteorological Data

Missing upper air data will be replaced as follows. Each year will be treated independently of the other years. If a day of data is missing, it will be filled with data from the day before. Data missing on January 1 will be filled with data from January 2 for each year. If two days are missing, data from the day before the first missing day will be used to fill the first missing day and data from the day after the second missing day will be used to fill the second missing day. A preliminary review indicated that there are no periods in the modeled years when more than two consecutive days are missing.

If CALMET indicates that there are errors in the data, the modeler will attempt to correct them. If the errors cannot be easily corrected, the data will be replaced with data from the previous day. The modeler will document the corrections and replacements of data in an appendix to the final modeling report.

3.3 Species Modeled

Six species will be modeled together in every CALPUFF simulation. The species are SO_2, SO_4, NO_X, HNO_3, NO_3, and PM_{10}. VOC and ammonia will not be modeled per the LDEQ flowchart in the "BART Determination Process" document.[7] Emissions of inhalable particulate matter (with an effective diameter less than 10 micrometers) will be speciated as recommended by the National Park Service[8] and as provided in Table 3-2.

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[6] Atmospheric Studies Group. "Land Use/Land Cover (LULC) data." ASG at TRC: Air Quality Modeling Data Sets. July 10, 2006. http://www.src.com/datasets/datasets_lulc.html

[7] Louisiana Department of Environmental Quality. "BART Determination Process." Current Issues. No Date. http://www.deq.louisiana.gov/portal/Portals/0/AirQualityAssessment/bart.doc.

[8] National Park Service. "Particulate Matter Speciation." Explore Air. March 28, 2006. http://www2.nature.nps.gov/air/Permits/ect/index.cfm

Table 3-2
PM_{10} Speciation

PM_{10} Total	Filterable				
	Total	**EC**		**Soil**	
100.00%	46.00%	6.70%	of Filterable	93.30%	of Filterable
		3.08%	of Total	42.92%	of Total
	Condensable				
	Total	**SO_4**		**SOA (OC)**	
	54.00%	66.00%	of Condensable	34.00%	of Condensable
		35.64%	of Total	18.36%	of Total

3.4 Sources Modeled

In early 2006, ConocoPhillips submitted an emissions inventory to the LDEQ in response to the BART survey conducted by the LDEQ. The emission units and rates from this inventory will be used in the refined BART modeling. Twenty-seven (27) units will be modeled, and 24-hour maximum potential emissions will be used in lieu of the highest actual daily emissions for the 2001-2003 period. Appendix A lists the units to be modeled, along with the corresponding stack parameters and emission rates. Only BART-eligible units will be included in the modeling. Per the Louisiana modeling guidelines, potential visibility impacts in the Breton Wilderness Area will be determined for all BART-eligible units as a group and, if the predictions for the group exceed 0.5 delta-dv, for each individual unit. Only units with impacts exceeding 0.5 delta-dv on the Breton Class I Area will be considered for BART engineering analysis.

3.5 Air Quality Database

Ammonia concentrations will be held constant per the LDEQ *BART Modeling Protocol.*[9] The value of 3 ppb will be used for ammonia. When calculating light extinction, relative humidity correction factors (*f*(RH)s) provided by CENRAP and listed in Table 3-3 will be entered into CALPOST. Please note that the values in Table 3-3 exceed the U.S. EPA Recommended Monthly Site-Specific f(RH) Values for Breton[10]; therefore, the modeling predictions are expected to be conservative.

Table 3-3
Monthly Averaged f(RH)

Class I Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breton Wilderness	3.7	3.5	3.7	3.6	3.8	4.0	4.3	4.3	4.2	3.7	3.7	3.7

[9] Louisiana Department of Environmental Quality (February 2007). *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana*, p. 11.
[10] U.S. EPA. "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program." EPA-454/B-03-005, September 2003. Table A-2, p. A-6.

Sage Environmental will use ozone concentration files provided by LDEQ.[11] Three files have been provided, each containing ozone concentration data for one year. A default value of 40 ppb will be used for hours in which ozone data are missing.

3.6 Natural Conditions at Class I areas

CALPOST uses monthly concentrations of aerosol components to compute background extinction coefficients. Sage Environmental will use the levels provided by CENRAP and listed in Table 3-4 when performing BART refined modeling.

Table 3-4
Average Annual Natural Levels of Aerosol Components (μg/m³)

Class I Area	SO4	NO3	OC	EC	Soil	Coarse Mass
Breton Wilderness	0.23	0.10	1.40	0.02	0.50	3.00

[11] Louisiana Department of Environmental Quality. *Ozone Data.* March 1, 2007. ftp://ftp-cenrap.ldeq.org/ozonedata.zip

SECTION 4
REFERENCES

Atmospheric Studies Group. *Land Use/Land Cover (LULC) data.* ASG at TRC: Air Quality Modeling Data Sets. July 10, 2006. http://www.src.com/datasets/datasets_lulc.html

Brewer, Pat. *Weight of Evidence: Residence Time Analyses.* September 22, 2005. http://www.vistas-sesarm.org/documents/VISTASJointWorkGroupMeeting09052005/7_Brewer_Residence%20time_20050922.ppt

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Dennis McNally, T. W. Tesche, and George Schewe. *CENRAP BART Modeling Guidelines.* Alpine Geophysics, LLC. Ft. Wright, Kentucky: December 15, 2005.

National Park Service. *Particulate Matter Speciation.* Explore Air. March 28, 2006. http://www2.nature.nps.gov/air/Permits/ect/index.cfm

U.S. Department of the Interior. *Class I Receptors.* National Park Service Nature & Science. November 18, 2005. http://www2.nature.nps.gov/air/maps/receptors/index.cfm

U.S. EPA. *Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations.* Federal Register, **70 (128)**, Wednesday, July 6, 2005.

U.S. EPA. *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program.* EPA-454/B-03-005, September 2003.

APPENDIX A
EMISSIONS DATABASE

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana

List of BART- Eligible Sources for Inclusion in BART Modeling

EPN	Description	Source ID	UTM Easting (X) (km)	UTM Northing (Y) (km)	Zone	Stack Height (m)	Base Elevation (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	Init. Sigma-y (m)	Init. Sigma-z (m)	Momentum Flux
1291-H-2/3	FCCU Light/Heavy Feed Heater	1291H23	212.246	3287.375	16	56.7	1.22	2.59	4.08	552	0	0	1
301-B-2A	CO Boiler	301B2A	212.232	3287.396	16	23.8	1.22	3.51	20.49	609.3	0	0	1
301-B-2B	CO Boiler	301B2B	212.21	3287.389	16	23.8	1.22	3.51	20.99	582	0	0	1
292-H-1	Light Distillate Gulfiner Reactor Heater	292H1	212.037	3287.241	16	28	0.61	1.22	2.44	595.9	0	0	1
292-H-2	Light Distillate Gulfiner Stabilizer Heater	292H2	212.032	3287.254	16	36.9	0.66	1.6	2	597	0	0	1
191-H-1	Crude Charge Heater	191H1	212.092	3287.117	16	63.7	0.61	4.69	8.05	465.9	0	0	1
191-H-2	Vacuum Charge Heater	191H2	212.103	3287.09	16	63.7	0.61	2.74	4.4	449.3	0	0	1
406-D-15	Product Dock No.1 MVR Loading	406D15	212.61	3286.993	16	7.6	1.52	0.79	20	1273.2	0	0	1
406-D-16	Product Dock No.2 MVR Loading	406D16	212.612	3286.984	16	7.6	1.52	0.79	20	1273.2	0	0	1
891-H-1	Delayed Coker Charge Heater	891H1	212.395	3287.189	16	50.3	1.22	2.29	6.01	605.4	0	0	1
891-CP	Coke Transfer and Storage	891CP	212.397	3287.217	16	1.00	1.22	1.00	0.001	298.15	0	0	1
491-H-1	Alkylation Isostripper Reboiler	491H1	212.252	3287.133	16	51.2	0.91	3.12	2.5	615.9	0	0	1
491-H-2	Alkylation Depropanizer Reboiler	491H2	212.269	3287.139	16	43	0.91	3.05	4.48	574.3	0	0	1
100-H-1	Coker Charge Storage Heater	100H1	212.47	3287.281	16	15.2	1.94	0.61	6.07	594.3	0	0	1
293-H-1	Heavy Distillate Gulfiner Reactor Feed Heater	293H1	212.051	3287.2	16	39.6	0.61	2.03	2.68	577.6	0	0	1
293-H-2	Heavy Distillate Gulfiner Stabilizer Reboiler	293H2	212.055	3287.187	16	34.4	0.61	1.92	4.42	603.7	0	0	1
1391-H-1	Catalytic Reformer Feed Heater No. 1	1391H1	212.015	3287.43	16	62.8	0.91	3.51	4.76	490.4	0	0	1
1391-H-2/3	Catalytic Reformer Feed Heater No. 2 & 3	1391H23	212.051	3287.443	16	65	0.91	3.93	3.75	763.1	0	0	1
1391-H-4	Depentanizer Reboiler	1391H4	212.025	3287.433	16	44.2	0.91	2.18	6.34	550.4	0	0	1
1391-H-5	Dry Reactivation Heater	1391H5	212.07	3287.45	16	42.2	0.91	2.2	1.49	550.4	0	0	1
1791-H-1	Reformate Splitter Reboiler	1791H1	212.056	3287.319	16	38.1	0.91	1.96	3.5	552	0	0	1
1792-H-1	Hydrodealkylation Charge Heater	1792H1	212.027	3287.269	16	45.1	0.7	2.29	4.24	552	0	0	1
291-H-1	Naphiner Reactor Feed Heater	291H1	212.042	3287.227	16	39.6	0.64	1.92	2.99	599.3	0	0	1
291-H-2	Naphiner Deisohexanizer Reboiler	291H2	212.045	3287.214	16	38.7	0.61	1.93	3.66	541.5	0	0	1
303-R-1	Cooling Water Tower No. 1	303R1P	212.177	3287.033	16	18.288	0.61	8.5344	8.534	303.15	0	0	1
308F-D-1	Low Pressure Flare	308FD1	212.51	3286.983	16	65	1.22	3.07	20	1273.2	0	0	1
308F-D-2	High Pressure Flare	308FD2	212.569	3286.81	16	65	1.09	2.15	20	1273.2	0	0	1

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana

List of BART- Eligible Sources for Inclusion in BART Modeling

EPN	Description	Source ID	SO_2	SO_2	SO_4	SO_4	NO_X	NO_X	EC	EC	Soil	Soil	OC	OC
			(g/s)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(lb/hr)
1291-H-2/3	FCCU Light/Heavy Feed Heater	1291H23	0.6792	5.3903	0.0668	0.5304	1.0097	8.0138	0.0058	0.0458	0.0805	0.6387	0.0344	0.2732
301-B-2A	CO Boiler	301B2A	69.3287	550.2371	2.3925	18.9884	19.1319	151.8434	0.2068	1.6410	2.8812	22.8671	1.2325	9.7819
301-B-2B	CO Boiler	301B2B	69.3287	550.2371	2.3925	18.9884	19.0972	151.5678	0.2068	1.6410	2.8812	22.8671	1.2325	9.7819
292-H-1	Light Distillate Gulfiner Reactor Heater	292H1	0.0930	0.7383	0.0094	0.0746	0.3389	2.6896	0.0008	0.0065	0.0113	0.0899	0.0048	0.0385
292-H-2	Light Distillate Gulfiner Stabilizer Heater	292H2	0.1636	1.2982	0.0163	0.1296	0.5958	4.7289	0.0014	0.0112	0.0197	0.1561	0.0084	0.0668
191-H-1	Crude Charge Heater	191H1	19.7917	157.0794	0.4538	3.6013	40.8565	324.2632	0.0392	0.3112	0.5464	4.3369	0.2338	1.8552
191-H-2	Vacuum Charge Heater	191H2	1.5042	11.9380	0.1485	1.1786	8.9472	71.0109	0.0128	0.1019	0.1788	1.4193	0.0765	0.6072
406-D-15	Product Dock No.1 MVR Loading	406D15	0.0056	0.0441	0.0238	0.1886	0.8819	6.9997	0.0021	0.0163	0.0286	0.2271	0.0122	0.0971
406-D-16	Product Dock No.2 MVR Loading	406D16	0.0056	0.0441	0.0238	0.1886	0.8819	6.9997	0.0021	0.0163	0.0286	0.2271	0.0122	0.0971
891-H-1	Delayed Coker Charge Heater	891H1	0.8967	7.1165	0.0886	0.7032	5.6333	44.7097	0.0077	0.0608	0.1067	0.8469	0.0456	0.3623
891-CP	Coke Transfer and Storage	891CP	0.0000	0.0000	0.0262	0.2082	0.0000	0.0000	0.0023	0.0180	0.0316	0.2507	0.0135	0.1073
491-H-1	Alkylation Isostripper Reboiler	491H1	0.8069	6.4044	0.0663	0.5264	5.1847	41.1493	0.0057	0.0455	0.0799	0.6340	0.0342	0.2712
491-H-2	Alkylation Depropanizer Reboiler	491H2	1.0111	8.0248	0.0832	0.6600	6.0167	47.7521	0.0072	0.0570	0.1001	0.7948	0.0428	0.3400
100-H-1	Coker Charge Storage Heater	100H1	0.0403	0.3197	0.0040	0.0314	0.1472	1.1684	0.0003	0.0027	0.0048	0.0378	0.0020	0.0162
293-H-1	Heavy Distillate Gulfiner Reactor Feed Heater	293H1	0.1812	1.4381	0.0238	0.1886	0.7917	6.2832	0.0021	0.0163	0.0286	0.2271	0.0122	0.0971
293-H-2	Heavy Distillate Gulfiner Stabilizer Reboiler	293H2	0.2298	1.8236	0.0272	0.2161	1.0042	7.9697	0.0024	0.0187	0.0328	0.2602	0.0140	0.1113
1391-H-1	Catalytic Reformer Feed Heater No. 1	1391H1	1.2778	10.1413	0.1262	1.0018	1.9000	15.0796	0.0109	0.0866	0.1520	1.2064	0.0650	0.5161
1391-H-2/3	Catalytic Reformer Feed Heater No. 2 & 3	1391H23	1.2611	10.0090	0.1242	0.9861	1.8750	14.8812	0.0107	0.0852	0.1496	1.1875	0.0640	0.5080
1391-H-4	Depentanizer Reboiler	1391H4	0.7167	5.6879	0.0708	0.5618	9.0139	71.5400	0.0061	0.0486	0.0852	0.6766	0.0365	0.2894
1391-H-5	Dry Reactivation Heater	1391H5	0.0389	0.3086	0.0040	0.0314	0.1431	1.1354	0.0003	0.0027	0.0048	0.0378	0.0020	0.0162
1791-H-1	Reformate Splitter Reboiler	1791H1	0.4597	3.6487	0.0455	0.3614	3.1944	25.3532	0.0039	0.0312	0.0548	0.4353	0.0235	0.1862
1792-H-1	Hydrodealkylation Charge Heater	1792H1	0.6222	4.9384	0.0614	0.4872	0.9250	7.3414	0.0053	0.0421	0.0739	0.5867	0.0316	0.2510
291-H-1	Naphiner Reactor Feed Heater	291H1	0.4764	3.7809	0.0470	0.3732	3.2986	26.1799	0.0041	0.0323	0.0566	0.4495	0.0242	0.1923
291-H-2	Naphiner Deisohexanizer Reboiler	291H2	0.3750	2.9762	0.0371	0.2946	2.6000	20.6353	0.0032	0.0255	0.0447	0.3548	0.0191	0.1518
303-R-1	Cooling Water Tower No. 1	303R1P	0.0000	0.0000	0.9870	7.8337	0.0000	0.0000	0.0853	0.6770	1.1886	9.4339	0.5085	4.0355
308F-D-1	Low Pressure Flare	308FD1	236.1111	1873.9292	0.0020	0.0157	3.3565	26.6392	0.0002	0.0014	0.0024	0.0189	0.0010	0.0081
308F-D-2	High Pressure Flare	308FD2	63.0787	500.6331	0.0020	0.0157	1.3889	11.0231	0.0002	0.0014	0.0024	0.0189	0.0010	0.0081

APPENDIX B
CALPUFF SPECIES

ConocoPhillips Company
Alliance Refinery
Belle Chasse, Louisiana

CALPUFF Species Parameters for Refined BART Modeling

	Dry (Gas)					Dry (Particle)		Wet	
Species	Diffusivity	Alpha Star	Reactivity	Meso. Resist.	Henry's Law	Geo. Mass Mean Diameter	Geometric Standard Deviation	Scavenging Coef. Liquid Precip.	Scavenging Coef. Frozen Precip.
	(cm^2/s)			(s/cm)		(microns)	(microns)	(1/s)	(1/s)
SO2	0.1509	1000	8	0	0.04	0	0	3.00E-05	0
SO4	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05
NOX	0.1656	1	8	5	3.5	0	0	0	0
HNO3	0.1628	1	18	0	8.00E-08	0	0	6.00E-05	0
NO3	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05
EC	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05
SOIL	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05
SOA	0	0	0	0	0	0.48	2	1.00E-04	3.00E-05

DEPARTMENT OF ENVIRONMENTAL QUALITY

DEQ LOUISIANA

KATHLEEN BABINEAUX BLANCO
GOVERNOR

MIKE D. McDANIEL, Ph.D.
SECRETARY

RECEIVED
APR 25 2007
L.R. POCHE'

April 12, 2007

Mr. Laurence R. Poche'
Environmental Superintendent
ConocoPhillips
P. O. Box 176
Belle Chasse, LA 70037

RE: Modeling protocol for ConocoPhillip Best Available Retrofit Technology (BART) Determination, ConocoPhillip, Alliance Refinery, Belle Chasse, Plaquemines Parish, Louisiana.

Dear Mr. Poche':

The Office of Environmental Assessment, Air Quality Assessment Division, Engineering Group I have no objection to the methodology proposed in the April 4, 2007 modeling protocol from Mr. Igor Shnayder of Sage Environmental Consulting, L.P.. for the subject facility. Any deviation from this protocol requires the submittal of an amended protocol and subsequent approval by this Office.

The modeling results should be submitted to our office no later than May 31, 2007.

Please contact me at (225)219-3490 if you have any questions.

Sincerely,

Sirisak Patrick Pakunpanya
Air Quality Dispersion
Modeling Coordinator

CC: Jennifer Mouton, Office of Air Quality Assessment Engineering Group I
Erik Snyder, EPA Region 6
Tim Allen, Federal Wild Life and Fishery

ENVIRONMENTAL ASSESSMENT
: PO BOX 4314, BATON ROUGE, LA 70821-4314
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ATTACHMENT III

DEPARTMENT OF ENVIRONMENTAL QUALITY

KATHLEEN BABINEAUX BLANCO
GOVERNOR

MIKE D. McDANIEL, Ph.D.
SECRETARY

January 23, 2007

CERTIFIED MAIL
RETURN RECEIPT REQUESTED #7004 1160 0000 3796 1247

Mr. Laurence R. Poche'
Environmental Superintendent
ConocoPhillips Company
P.O. Box 176
Belle Chasse, LA 70037

RE: Best Available Retrofit Technology (BART) Determination
ConocoPhillips, Alliance Refinery, AI # 2418
Belle Chasse, Plaquemines Parish, Louisiana.

Dear Mr. Poche':

The Louisiana Department of Environmental Quality is in the process of conducting preliminary screening modeling to determine which sources in Louisiana may be subject to the Best Available Retrofit Technology portion of the Regional Haze Rules. The screening model results indicate that the BART-eligible source emissions at the ConocoPhillips Alliance Refinery may have the potential to exceed acceptable overall Regional Haze Rule (RHR) visibility improvement goals in the Breton Wildlife Refuge class I area.

Since the preliminary screening run indicates potential visibility impacts at Breton Wildlife Refuge, we are recommending that a refined air dispersion modeling study be performed. Please contact Mr. Patrick Pakunpanya, Environmental Chemical Specialist, at (225) 219-3490 to arrange a meeting to discuss the modeling protocol and guidance.

Sincerely,

Jennifer J. Mouton

Jennifer J. Mouton
Environmental Scientist Manager
Air Quality Assessment Division

JJM/spp

c: Chris Roberie, Administrator, AQAD
Teri Lanoue, Environmental Scientist Manager, AQAD SIP Planning

ENVIRONMENTAL **ASSESSMENT**
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ATTACHMENT IV

Kelly Bradberry

From: Yvette McGehee [Yvette.McGehee@LA.GOV]
Sent: Wednesday, June 06, 2007 4:36 PM
To: Kelly Bradberry
Cc: Vivian Aucoin; James Orgeron
Subject: Draft ConocoPhillips Alliance BART Engineering Analysis

Ms. Bradberry,

We have reviewed your Draft BART Engineering Analysis for ConocoPhilips and we have a few comments.

For the flare with NSPS controls we need you to include a discussion of whether any new technologies have subsequently become available.

Also the charge heater is also a large source and we think that you should include a BACT analysis of this piece of equipment explaining why no controls have been applied to it and do the BART 5 factor analysis under 51.308 (e)(1)(ii)(A).

Yvette McGehee
LDEQ

ATTACHMENT V

Consent Decree Allowable Control Options

J. NSPS Applicability of Flaring Devices

138. NSPS Applicability of Flaring Devices. COPC owns and operates the Flaring Devices that are identified in Appendix A. These Flaring Devices are or will become affected facilities as that term is used in the NSPS at such time as COPC certifies compliance and accepts NSPS applicability under Paragraphs 142 - 143.

139. Compliance Methods for Flaring Devices. For each Flaring Device, COPC will elect to use one or any combination of following compliance methods:

(a) Operate and maintain a flare gas recovery system to control continuous or routine combustion in the Flaring Device. Use of a flare gas recovery system on a flare obviates the need to continuously monitor and maintain records of hydrogen sulfide in the gas as otherwise required by 40 C.F.R. §§ 60.105(a)(4) and 60.7;

(b) Operate the Flaring Device as a fuel gas combustion device and comply with NSPS monitoring requirements by use of a CEMS pursuant to 40 C.F.R. § 60.105(a)(4) or with a predictive monitoring system approved by EPA as an alternative monitoring system pursuant to 40 C.F.R. § 60.13(i);

(c) Eliminate the routes of continuous or intermittent, routinely-generated fuel gases to a Flaring Device and operate the Flaring Device such that it receives only process upset gases, fuel gas released as a result of relief valve leakage or gases released due to other emergency malfunctions; or

(d) Eliminate to the extent practicable routes of continuous or intermittent, routinely-generated fuel gases to a Flaring Device and monitor the Flaring Device by use of a CEMS and a flow meter; provided however, that this compliance method may not be used unless COPC: (i) demonstrates to EPA that the Flaring Device in question emits less than 500 pounds per day of SO_2 under normal conditions; (ii) secures EPA approval for use of this method as the selected compliance method; and (iii) uses this compliance method for five or fewer of the Flaring Devices listed in Appendix A.

140. For the compliance method described in Paragraph 139(b), to the extent that COPC seeks to use an alternative monitoring method at a particular Flaring Device to demonstrate compliance with the limits at 40 C.F.R. § 60.104(a)(1), COPC may begin to use the method immediately upon submitting the application for approval to use the method, provided that the alternative method for which approval is being sought is the same as or is substantially similar to the method identified as the "Alternative Monitoring Plan for NSPS Subpart J Refinery Fuel Gas" attached to EPA's December 2, 1999, letter to Koch Refining Company LP.

141. Compliance Plan for Flaring Devices (Paragraphs 141 - 142). For each Covered Refinery, COPC will submit a Compliance Plan for Flaring Devices to EPA and the Applicable Co-Plaintiff by no later than December 31, 2007. The Plan will have the objective of reducing to the extent practicable: (i) the routing of continuous or intermittent, routinely-generated fuel gas streams that contain hydrogen sulfide of greater than 230 mg/dscm (0.10 gr/dscf) to Flaring Devices; and (ii) the characterization of streams that COPC considers to be the result of alleged malfunctions, process upsets, and/or relief valve leakage by taking into consideration the source and frequency of the stream.

142. In each Refinery's Compliance Plan for Flaring Devices, COPC will:

(a) Certify compliance with one of the four compliance methods set forth in Paragraph 139 and accept NSPS applicability for at least (i) 50% of the system-wide Flaring Devices identified in Appendix A; and (ii) one Flaring Device per Refinery where such Refinery has three or more Flaring Devices;

(b) Identify the Paragraph 139 compliance method used for each Flaring Device that COPC identifies under Subparagraph 142(a);

(c) Describe the activities that COPC has taken or anticipates taking, together with a schedule, to meet the objectives of Paragraph 141 at each Refinery; and

(d) Describe the anticipated compliance method and schedule that COPC will undertake for the remaining Flaring Devices identified in Appendix A.

143. By no later than December 31, 2011, COPC will certify compliance to EPA and the Applicable Co-Plaintiff with one of the four compliance methods in Paragraph 139 and will accept NSPS applicability for all of the Flaring Devices in Appendix A.

144. Performance Tests. By no later than ninety (90) days after bringing a Flaring Device into compliance by using one or more of the methods in Paragraph 139, COPC will conduct a flare performance test pursuant to 40 C.F.R. §§ 60.8 and 60.18, or an EPA-approved equivalent method. In lieu of conducting the velocity test required in 40 C.F.R. § 60.18, COPC may submit velocity calculations that demonstrate that the Flaring Device meets the performance specification required by 40 C.F.R. § 60.18.

145. The combustion in a Flaring Device of process upset gases or fuel gas that is released to the Flaring Device as a result of relief valve leakage or other emergency malfunctions is exempt from the requirement to comply with 40 C.F.R. § 60.104(a)(1).

146. Good Air Pollution Control Practices. On and after the Date of Entry of this Decree, COPC, at all times, including during periods of startup, shutdown, and or Malfunction, will, to the extent practicable, maintain and operate the Flaring Devices in Appendix A, and associated air pollution control equipment, in a manner consistent with good air pollution control practices for minimizing emissions pursuant to 40 C.F.R. § 60.11(d).

147. Compliance with Consent Decree Constitutes Compliance with Certain NSPS Subpart A Requirements. For Flaring Devices that become affected facilities under NSPS Subpart J pursuant to Paragraphs 142 and 143, entry of this Consent Decree and compliance with the relevant monitoring requirements of this Consent Decree for Flaring Devices will satisfy the notice requirements of 40 C.F.R. § 60.7(a) and the initial performance test requirement of 40 C.F.R. § 60.8(a).

148. Periodic Maintenance of Flare Gas Recovery Systems. The Parties recognize that periodic maintenance may be required for properly designed and operated flare gas recovery systems. To the extent that COPC currently operates or will operate flare gas recovery systems, COPC will take all reasonable measures to minimize emissions while such periodic maintenance is being performed.

149. Safe Operation of Refining Processes. The Parties recognize that under certain conditions, a flare gas recovery system may need to be bypassed in the event of an emergency or in order to ensure safe operation of refinery processes. Nothing in this Consent Decree precludes COPC from temporarily bypassing a flare gas recovery system under such circumstances.

ENVIRON

Best Available Retrofit Technology Analysis

Mosaic Fertilizer LLC
Uncle Sam Plant
AI Number 2532

Prepared for:

Mosaic Fertilizer LLC
St. James, Louisiana

Prepared by:

ENVIRON International Corporation

June 2007
Project No. 26-18160A

8235 YMCA Plaza, Suite 300, Baton Rouge, LA 70810 Tel: 225.408.2696

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1. INTRODUCTION

1.1 Background information

In 1999, the EPA promulgated rules to address visibility impairment – often referred to as "regional haze" – at designated federal Class I areas. These include areas such as national parks and wilderness areas where visibility is considered to be an important part of the visitor experience.[1] There is one Class I area in Louisiana, Breton Wilderness Area, as well as others in surrounding states. Guidelines providing direction to the states for implementing the regional haze rules were issued by EPA in July 2005. Affected states, including Louisiana, are required to develop plans for addressing visibility impairment. This includes a requirement that certain existing sources be equipped with Best Available Retrofit Technology, or BART. Louisiana is required to submit a regional haze plan to EPA no later than December 17, 2007.

1.2 Potentially Affected Sources

The LDEQ has identified potentially BART-affected sources as those:

- Belonging to one of 26 industry source categories;[2]
- Having the potential to emit (PTE) 250 tons per year or more of any visibility-impairing pollutant; and
- Not in operation prior to August 7, 1962, and in existence on August 7, 1977.

Based on results of a CALPUFF modeling analysis performed by the LDEQ, 28 facilities in Louisiana were identified as potentially BART-eligible. These facilities were sent letters indicating that they should perform detailed CALPUFF screening or refined modeling to determine if they have the potential to significantly impact – impacts of 0.5 deciview (dv) or greater – one or more Class I areas.[3] The Mosaic Fertilizer LLC (Mosaic) Uncle Sam Plant is one of these 28 facilities.

1.3 Mosaic Uncle Sam Plant BART Approach

Mosaic retained ENVIRON International Corporation (ENVIRON) to perform a source-specific Best Available Retrofit Technology (BART) refined modeling analysis using the CALPUFF model for the Mosaic Uncle Sam Plant located near St. James, Louisiana. The CALPUFF modeling, performed in

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[1] 40 CFR 51, Subpart P

[2] (1) fossil fuel-fired steam electric plants of more than 250 MMBtu/hour heat input; (2) coal-cleaning plants (thermal dryers); (3) Kraft pulp mills; (4) Portland cement plants; (5) primary zinc smelters; (6) iron and steel mill plants; (7) primary aluminum ore reduction plants; (8) primary copper smelters; (9) municipal incinerators capable of charging more than 250 tons of refuse per day; (10) hydrofluoric, sulfuric, and nitric acid plants; (11) petroleum refineries; (12) lime plants; (13) phosphate rock processing plants; (14) coke oven batteries; (15) sulfur recovery plants; (16) carbon black plants (furnace process); (17) primary lead smelters; (18) fuel conversion plants; (19) sintering plants; (20) secondary metal production facilities; (21) chemical process plants; (22) fossil fuel-fired boilers of more than 250 MMBtu/hour heat input; (23) petroleum storage and transfer facilities with capacity exceeding 300,000 barrels; (24) taconite ore processing facilities; (25) glass fiber processing plants; and (26) charcoal production facilities.

[3] A *deciview* (dv) is a measure of visibility impairment.

response to a request from the Louisiana Department of Environmental Quality (LDEQ), was conducted in accordance with the approved modeling protocol (Attachment A) as well as LDEQ and Central States Regional Air Planning Association (CENRAP) guidance.[4,5] The modeling analysis shows that, using current permit maximum hourly emission rates, visibility impacts may be significant at one Class I area (Breton Wilderness Area). The impact on visibility was a result of a significant emission source, the A-Train Sulfuric Acid Stack. Mosaic is reviewing possibilities for future control strategies on the A-Train Sulfuric Acid Stack that could be expected to reduce SO_2 emissions for the facility, and is discussing this matter with regulatory authorities. For the purposes of performing a refined modeling analysis and exempting the source from BART requirements, Mosaic Uncle Sam plant reviewed potential emission rates for the A-Train Sulfuric Acid Stack. The modeling data input considered a future potential emission rate of 258.3 lbs/hr (maximum basis). (This number is subject to change based on continuing review and discussions.) The current operating emissions rate is estimated to be 2,250.1 lbs/hr (maximum basis).

Per discussions on June 6, 2007 with Mr. James Orgeron of LDEQ's SIP Planning Section, if Mosaic could demonstrate that implementing a control strategy for A-Train emissions lowered visibility impacts to below the significance threshold (0.5 dv) at all Class I areas, a BART engineering analysis would not be required. As provided in Section 4, CALPUFF Modeling Results, Mosaic has successfully demonstrated that Mosaic's modeled emission rate would be expected to lower emissions of visibility-impairing pollutants to the point that visibility impacts at all Class I areas will be insignificant. Mosaic would be pleased in the coming months to review the status of its consideration of control strategies with LDEQ for the A-Train sulfuric acid stack, and looks forward to initiating a plan of action to address future emission reduction projects prior to the BART control implementation date.

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[4] Louisiana Department of Environmental Quality (LDEQ). *Best Available Retrofit Technology Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana*. February 2007.

[5] Alpine Geophysics, LLC.2005. *CENRAP BART Modeling Guidelines*.

2. CALPUFF MODELING APPROACH

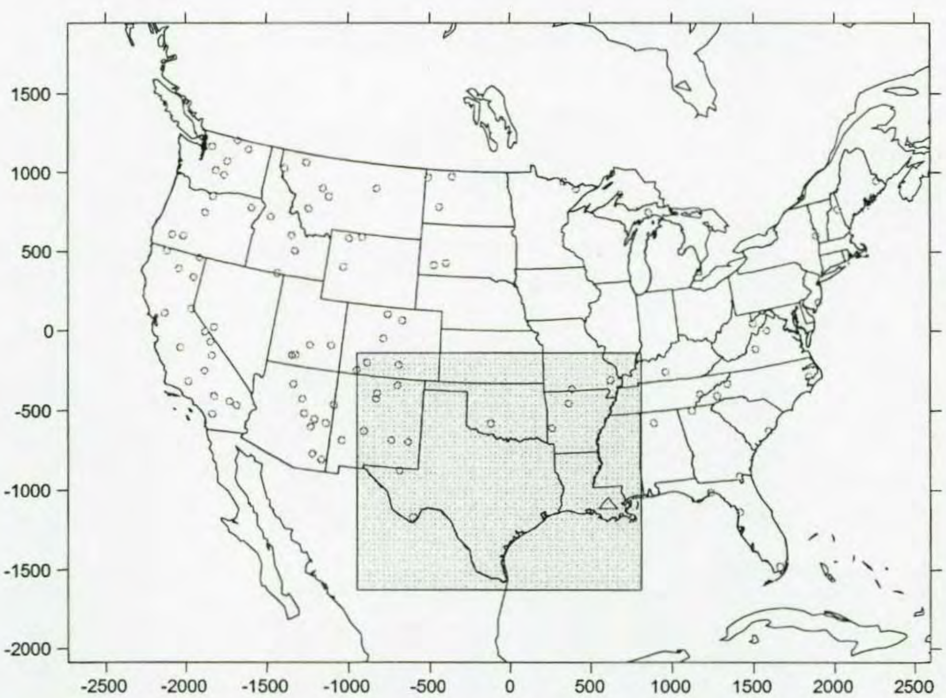
2.1 Overview

The LDEQ has adopted one of the air quality modeling approaches in EPA's BART guidance which is an individual source attribution approach. Specifically, this entails modeling source-specific BART-eligible units and comparing modeled impacts to the deciview threshold. The modeling approach discussed here is specifically designed for conducting a source-specific BART refined modeling analysis.

2.2 Class I Areas to Assess

Figure 2-1 shows the location of the CENRAP South Domain (yellow box), Class I areas (red circles) and the Mosaic Uncle Sam Plant (green triangle). Lambert Conformal Projection (LCP) coordinates are shown.

Figure 2-1. CENRAP South Domain



The Mosaic Uncle Sam Plant is located approximately 180 km from Breton Wilderness Area (BRET1), the closest Class I Area. There are no other Class I Areas located within 300 km of the Mosaic Uncle Sam Plant. The next closest Class I Area is the Caney Creek Wilderness Area in Arkansas (CACR1), which is located approximately 560 km from the Mosaic Uncle Same Plant. As agreed to by the LDEQ, the refined modeling analysis performed for the Mosaic Uncle Sam Plant is limited to Breton and Caney Creek.

2.3 Air Quality Model and Inputs

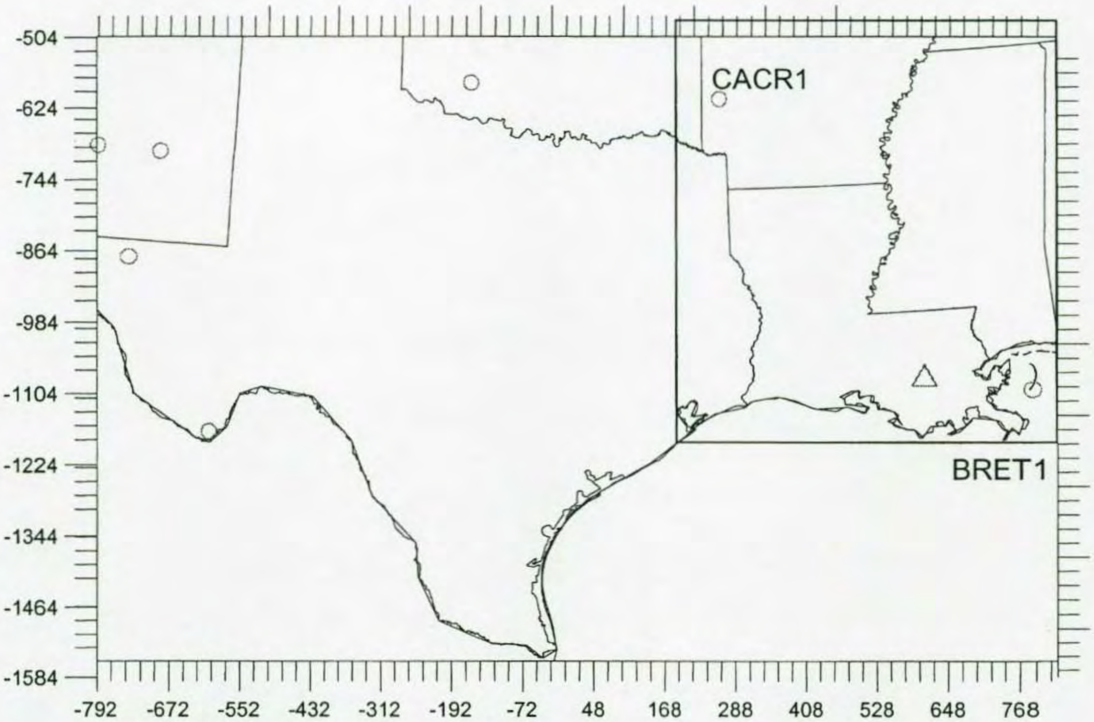
2.3.1 Modeling Domains

The CALPUFF refined modeling analysis is conducted on a portion of the CENRAP south domain, using 6 km grid spacing. The domain extends at least 50 km to the east and south of the Breton Wilderness Area and at least 50 km to the north and west of the Caney Creek Wilderness Area. The domain extents are as follows (Lambert Conformal Projection Coordinates):

- SW Corner (1,1): 180.0 km, -1188.0 km
- NX, NY: 108, 120
- DX, DY: 6 km, 6 km

Figure 2-2 shows the location of the CALPUFF refined modeling domain (yellow box), Class I areas (red circles) and the Mosaic Uncle Sam Plant (green triangle). LCP coordinates are shown.

Figure 2-2. CALPUFF Modeling Domain



2.3.2 *CALPUFF System Implementation*

There are three main components to the CALPUFF model:

- Meteorological Data Modeling (CALMET);
- Dispersion Modeling (CALPUFF); and
- Post-processing (POSTUTIL / CALPOST).

Versions of the modeling components that are used in source-specific subject-to-BART refined modeling analysis are presented in Table 2-1. Note that the following processors are not used in this analysis because the Mosaic Uncle Sam Plant analysis utilized the existing CENRAP-developed geophysical data file: TERREL, CTGCOMP, CTGPROC, and MAKEGEO. CALMM5 data is provided by CENRAP.

Table 2-1. CALPUFF Modeling Components

Processor	Version	Level
TERREL	3.311	030709
CTGCOMP	2.42	030709
CTGPROC	2.42	030709
MAKEGEO	2.22	030709
CALMM5	2.4	050413
CALMET	5.53a	040716
CALPUFF	5.711a	040716
POSTUTIL	1.3	030402
CALPOST	5.51	030709

2.3.3 *Meteorological Data Modeling (CALMET)*

LDEQ guidance recommends using observational data in refined CALPUFF modeling based on preferences of both the EPA and Federal Land Managers (FLMs). Since a refined modeling analysis is conducted for the Mosaic Uncle Sam Plant, observational data is incorporated during CALMET processing. A listing of CALMET inputs used in this analysis is presented in Attachment B.

The CALMM5 dataset was obtained from CENRAP for use in creating the CALMET outputs. The CALMET outputs consist of 10 vertical layers (11 layer interfaces). The top interface in the CALMET simulation is 4,000 meters. For the Mosaic Uncle Sam Plant analysis, surface, precipitation, and upper air observational data are incorporated during CALMET processing. Meteorological stations are selected from within the CENRAP south domain. A listing of the surface and precipitation stations is presented in Attachment C. Table 2-2 presents the Upper Air Stations to be used in CALMET processing. At a minimum, the upper air data file from each station contains data from mandatory sounding levels.

Table 2-2. Upper Air Stations

Station Name	Initials	Latitude (deg)	Longitude (deg)
Albuquerque, New Mexico	ABQ	35.05 N	106.62 W
Amarillo, Texas	AMA	35.23 N	101.70 W
Brownsville, Texas	BRO	25.90 N	97.43 W
Corpus Christi, Texas	CRP	27.77 N	97.50 W
Del Rio, Texas	DRT	29.37 N	100.92 W
Dodge City, Kansas	DDC	37.77 N	99.97 W
Fort Worth, Texas	FWD	32.80 N	97.30 W
Jackson, Mississippi (Thompson Field)	JAN	32.32 N	90.07 W
Lake Charles, Louisiana	LCH	30.12 N	93.22 W
Midland, Texas	MAF	31.93 N	102.20 W
Norman, Oklahoma	OUN	35.23 N	97.47 W
North Little Rock, Arkansas	LZK	34.83 N	92.27 W
Santa Teresa, New Mexico	EPZ	31.90 N	106.70 W
Shreveport, Louisiana	SHV	32.45 N	93.83 W
Slidell, Louisiana	SIL	30.33 N	89.82 W
Springfield, Missouri (Regional Airport)	SGF	37.23 N	93.40 W

Surface observations from the seven Western Gulf of Mexico National Oceanic and Atmospheric Administration's National Data Buoy Center (NDBC) Buoys are used in CALMET processing. These buoys are listed in Table 2-3.

Table 2-3. NDBC Buoys

Buoy Number	Latitude (deg)	Longitude (deg)
42001	25.90 N	89.67 W
42002	25.17 N	94.42 W
42007	30.09 N	88.77 W
42019	27.91 N	95.36 W
42020	26.96 N	96.70 W
42035	29.22 N	94.40 W
42040	29.18 N	88.21 W

For the Mosaic Uncle Sam Plant refined BART analysis, CALPUFF was run with three annual simulations spanning the years 2001 through 2003.

2.3.4 *Source Parameters*

Only emissions from BART-eligible emission units are included in the evaluation. There are 13 BART-eligible emission units at the Mosaic Uncle Sam Plant that emit or have the potential to emit under normal operations one or more visibility-impairing pollutants: NO_X, SO_2, and/or PM_{10}.

Source parameters required for modeling BART-eligible units are height of the stack opening from ground, inside stack diameter, exit gas flow rate, exit gas temperature, base elevation above sea level, and source location coordinates. Source parameters used in modeling the Mosaic Uncle Sam Plant analysis are presented in Tables 2-4 and 2-5. The only change in source parameters is for source (EQT067).

Table 2-4. Source Parameters – Current Configuration

Source ID	LCP Coordinates		Height (m)	Base Elevation (m)	Diameter (m)	Velocity (m/s)	Temperature (°K)
	X (km)	Y (km)					
(EQT067)	597.327	-1085.357	60.96	7.2	1.52	35.9	361
(EQT068)	597.377	-1085.360	10.36	7.2	0.76	55.9	366
(FUG002)	597.317	-1085.396	1.00	7.2	0.001	0.001	0
(EQT072)	597.453	-1085.366	19.81	7.2	1.83	22.1	672
(EQT073)	597.447	-1085.355	19.81	7.2	1.83	22.1	672
(FUG004)	596.784	-1085.555	1.00	7.2	0.001	0.001	0
(EQT074)	597.435	-1085.505	48.77	7.2	1.83	19.3	350
(EQT075)	597.418	-1085.489	9.14	7.2	0.76	54.8	355
(FUG003)	597.374	-1085.518	1.00	7.2	0.001	0.001	0
(EQT079)	597.035	-1085.401	1.00	7.2	0.001	0.001	0
(EQT081)	597.257	-1085.376	1.00	7.2	0.001	0.001	405
(EQT082)	597.282	-1085.403	13.05	7.2	0.40	0.001	394
(EQT083)	597.270	-1085.369	12.77	7.2	0.40	0.001	405

CENRAP guidance recognizes that downwash is important only at short distances (within 20 km) and recommends use of building downwash algorithms for consistency purposes only if the data are available. For the Mosaic Uncle Sam Plant, downwash data is not readily available and, given the distance to the nearest Class I area (180 km), there is no technical reason to include the effects of building downwash. Therefore, building downwash affects is not be included in this analysis.

Table 2-5. Source Parameters – Future Configuration

Source ID	LCP Coordinates		Height (m)	Base Elevation (m)	Diameter (m)	Velocity (m/s)	Temperature (°K)
	X (km)	Y (km)					
(EQT067)	597.327	-1085.357	30.48	7.2	1.83	18.9	353
(EQT068)	597.377	-1085.360	10.36	7.2	0.76	55.9	366
(FUG002)	597.317	-1085.396	1.00	7.2	0.001	0.001	0
(EQT072)	597.453	-1085.366	19.81	7.2	1.83	22.1	672
(EQT073)	597.447	-1085.355	19.81	7.2	1.83	22.1	672
(FUG004)	596.784	-1085.555	1.00	7.2	0.001	0.001	0
(EQT074)	597.435	-1085.505	48.77	7.2	1.83	19.3	350
(EQT075)	597.418	-1085.489	9.14	7.2	0.76	54.8	355
(FUG003)	597.374	-1085.518	1.00	7.2	0.001	0.001	0
(EQT079)	597.035	-1085.401	1.00	7.2	0.001	0.001	0
(EQT081)	597.257	-1085.376	1.00	7.2	0.001	0.001	405
(EQT082)	597.282	-1085.403	13.05	7.2	0.40	0.001	394
(EQT083)	597.270	-1085.369	12.77	7.2	0.40	0.001	405

2.3.5 Emission Rates

LDEQ and CENRAP guidance identifies the following priority approach for determining maximum 24-hour actual emission rates to be used in a BART visibility impairment modeling analysis:

1. Continuous emission monitoring (CEM) data;
2. Facility emissions tests;
3. Emission factors;
4. Permit limits; or lastly,
5. Potential to emit.

Worst-case 24-hour emissions are estimated using permit allowable 1-hour emission limits for both the current and future control scenarios. Since these limits are never to be exceeded during any one-hour period, their use to estimate worst-case 24-hour emissions is highly conservative. A summary of current and future emission rates used in the Mosaic Uncle Sam Plant modeling analysis is presented in Table 2-6. The only change between current and future emission scenarios is the reduction in SO_2 emissions from source (EQT067).

Table 2-6. Current and Future Permitted Emission Rates

Source ID	Current Emission Rates (lbs/hour)			Future Emission Rates (lbs/hour)		
	NO_X	SO_2	PM_{10}	NO_X	SO_2	PM_{10}
(EQT067)	10.00	2,250.16	NA	10.00	258.30	NA
(EQT068)	32.31	0.07	0.88	32.31	0.07	0.88
(FUG002)	NA	115.69	NA	NA	115.69	NA
(EQT072)	43.08	0.09	1.17	43.08	0.09	1.17
(EQT073)	43.08	0.09	1.17	43.08	0.09	1.17
(FUG004)	NA	0.14	0.69	NA	0.14	0.69
(EQT074)	11.25	375.00	NA	11.25	375.00	NA
(EQT075)	32.31	0.07	0.88	32.31	0.07	0.88
(FUG003)	NA	186.88	NA	NA	186.88	NA
(EQT079)	NA	NA	1.81	NA	NA	1.81
(EQT081)	NA	0.13	0.44	NA	0.13	0.44
(EQT082)	NA	0.28	0.98	NA	0.28	0.98
(EQT083)	NA	0.28	0.98	NA	0.28	0.98
TOTAL	**172.03**	**2,928.88**	**9.00**	**172.03**	**937.02**	**9.00**

Species included in the modeling analysis are listed in Table 2-7. For purposes of modeling the Mosaic Uncle Sam Plant, it is conservatively assumed that all particulate matter is PM-fine ($PM_{2.5}$). Source Classification Codes (SCC) and output from the Sparse Matrix Operator Kernel Emissions (SMOKE) program are used to further refine the estimate of PM species into sulfate (SO_4), nitrate (NO_3), elemental carbon (EC), organic carbon (OC) and unspeciated fine particulates (PMF). CALPUFF computes concentrations of HNO_3.

Table 2-7. Species Included in BART Refined Modeling Analysis

Species	Modeled	Directly Emitted	Dry Deposited
SO_2	Yes	Yes	Computed-gas
SO_4	Yes	No	Computed-particle
NO_X	Yes	Yes	Computed-gas
HNO_3	Yes	No	Computed-gas
NO_3	Yes	No	Computed-particle
EC	Yes	Yes	Computed-particle
OC (SOA)	Yes	Yes	Computed-particle
PM-fine ($PM_{2.5}$)	Yes	Yes	Computed-particle
PM-coarse ($PM_{10-2.5}$)	Yes	Yes	Computed-particle

Mosaic Uncle Sam Plant modeled emission rates are presented in Tables 2-8 and 2-9.

Table 2-8. Emission Rates – Current Scenario

Emission Point	Emission Rate (g/s)[1]								
	SO_2	SO_4	NO_X	HNO_3	NO_3	EC	OC	PMC	PMF
(EQT067)	283.5155	0.0000	1.2600	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(EQT068)	0.0087	0.0221	4.0707	0.0000	0.0006	0.0000	0.0663	0.0000	0.0215
(FUG002)	14.5762	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(EQT072)	0.0116	0.0295	5.4276	0.0000	0.0008	0.0000	0.0884	0.0000	0.0286
(EQT073)	0.0116	0.0295	5.4276	0.0000	0.0008	0.0000	0.0884	0.0000	0.0286
(FUG004)	0.0174	0.0027	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0843
(EQT074)	47.2492	0.0000	1.4175	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(EQT075)	0.0087	0.0221	4.0707	0.0000	0.0006	0.0000	0.0663	0.0000	0.0215
(FUG003)	23.5462	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(EQT079)	0.0000	0.0129	0.0000	0.0000	0.0020	0.0037	0.0257	0.0000	0.1836
(EQT081)	0.0159	0.0018	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0540
(EQT082)	0.0349	0.0038	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.1186
(EQT083)	0.0349	0.0038	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.1186

[1]SO_2 = gaseous sulfur dioxide; SO_4 = particulate sulfate; NO_X = gaseous nitrogen oxides
HNO_3 = gaseous nitric acid; NO_3 = particulate nitrate; EC = particulate elemental carbon
OC = particulate organic carbon; PMC = coarse particulate matter; PMF = fine particulate matter

Table 2-9. Emission Rates – Future Scenario

Emission Point	Emission Rate (g/s)[1]								
	SO_2	SO_4	NO_X	HNO_3	NO_3	EC	OC	PMC	PMF
(EQT067)	32.5453	0.0000	1.2600	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(EQT068)	0.0087	0.0221	4.0707	0.0000	0.0006	0.0000	0.0663	0.0000	0.0215
(FUG002)	14.5762	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(EQT072)	0.0116	0.0295	5.4276	0.0000	0.0008	0.0000	0.0884	0.0000	0.0286
(EQT073)	0.0116	0.0295	5.4276	0.0000	0.0008	0.0000	0.0884	0.0000	0.0286
(FUG004)	0.0174	0.0027	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0843
(EQT074)	47.2492	0.0000	1.4175	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(EQT075)	0.0087	0.0221	4.0707	0.0000	0.0006	0.0000	0.0663	0.0000	0.0215
(FUG003)	23.5462	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(EQT079)	0.0000	0.0129	0.0000	0.0000	0.0020	0.0037	0.0257	0.0000	0.1836
(EQT081)	0.0159	0.0018	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0540
(EQT082)	0.0349	0.0038	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.1186
(EQT083)	0.0349	0.0038	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.1186

Particle size parameters are entered in the CALPUFF input file for dry and wet deposition of particles. For the Mosaic Uncle Sam Plant refined modeling analysis, default values for "aerosol" species (e.g., SO_4, NO_3, and $PM_{2.5}$) of 0.48 μm geometric mass mean diameter and 2.0 μm geometric standard deviation are used.

2.3.6 Dispersion Model (CALPUFF)

CALMET output is used as input to the CALPUFF model. CALMET simulates the effects of meteorological conditions on the transport and dispersion of pollutants from an individual source. In general, the default options are used in the CALPUFF analysis. An exception is the use of puff-splitting in the analysis conducted for the Mosaic Uncle Sam Plant. A listing of CALPUFF control file inputs is presented in Attachment D.

2.3.6.1 Ozone and ammonia concentrations

Ozone (O_3) and ammonia (NH_3) may be input to CALPUFF as either hourly or monthly background values. LDEQ provided all O_3 data to ENVIRON. Background hourly O_3 concentrations for 2002 are derived from regional model simulations obtained from CENRAP. LDEQ provided 2001 and 2003 hourly O_3 concentrations from ambient monitors in Louisiana. NH_3 concentrations are assumed to be temporally and spatially invariant and are fixed at 3 ppb across the entire domain for all months.

2.3.6.2 Receptors

Receptors are locations where model results are calculated and provided in the CALPUFF output files. Receptor locations are derived from the National Park Service (NPS) Class I area receptor database.[6] The receptors are kept at the one (1) km spacing provided by the NPS.

2.3.6.3 Model Output

CALPUFF modeling results are displayed in units of micrograms per cub meter (μg/m^3). CALPUFF output files are post-processed using CALPOST to determine visibility impacts in deciviews.

2.3.7 Post-Processing (POSTUTIL and CALPOST)

Hourly concentration outputs from CALPUFF are processed using POSTUTIL and CALPOST to determine impacts on visibility. POSTUTIL takes the concentration file output from CALPUFF and recalculates the nitric acid and nitrate partition based on total available sulfate and ammonia. CALPOST uses the concentration file processed through POSTUTIL, along with relative humidity data, to perform visibility calculations. POSTUTIL and CALPOST control file inputs are presented in Attachments E and F, respectively.

Light extinction must be determined in order to calculate visibility. CALPOST has seven methods for computing light extinction. The Mosaic Uncle Sam Plant analysis uses Method 6, which computes extinction

[6] http://www2.nature.nps.gov/air/maps/receptors/index.cfm.

from speciated particulate matter with monthly Class I area-specific relative humidity adjustment factors. Relative humidity correction factors [*f*(RH)s] are applied to sulfate and nitrate concentration outputs from CALPUFF. Relative humidity correction factors are obtained from EPA's "Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule."[7] The $PM_{2.5}$ concentrations are considered part of the dry light extinction equation and do not have a humidity adjustment factor. The light extinction equation is the sum of the wet sulfate and nitrate and dry components ($PM_{2.5}$ plus Rayleigh scattering) which is 10 inverse megameters (Mm^{-1}).

Perceived visibility in deciviews is derived from the light extinction coefficient. The visibility change related to background is calculated using the modeled and established natural visibility conditions. For the Mosaic Uncle Sam Plant evaluation, daily visibility is expressed as a change in deciviews compared to natural visibility conditions. Natural visibility conditions are based on the annual average natural levels of aerosol components at each Class I area taken from the EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule."[8]

To determine whether or not a source may significantly contribute to visibility impairment at a Class I area, in a refined CALPUFF analysis, the 98^{th} percentile (8^{th} highest value in any year) is compared to a threshold value of 0.5 dv. If the 8^{th} highest impacts for each of the three modeled years are less than 0.5 dv, the source is considered to have an insignificant impact on visibility in the Class I area and is exempt from the requirement to perform a BART analysis or install BART controls.

2.3.8 Model Code Recompilation

To ensure compatibility with the CENRAP-developed files, CALMET, CALPUFF, POSTUTIL and CALPOST model codes were recompiled using the Lahey-Fujitsu FORTRAN Express v7.1 compiler after making changes to the respective parameter files as follows (new parameter value provided).

- *CALMET (modified params.met)*
  - MXNX = 306
  - MXNY = 246
  - MXSS = 375
  - MXPS = 375
  - MXNXP = 228
  - NXNYP = 236
- *CALPUFF (modified params.puf):*

[7] U.S. EPA (September 2003). *Regional Haze: Estimating Natural Visibility Conditions Under the Regional Haze Rule*. EPA-454/B-03-005.

[8] Ibid.

- MXNX = 306
- MXNXG = 306
- MXSS = 375
- MXPUFF = 100500

- *POSTUTIL (modified params.utl):*
  - MXGX = 306
  - MXGY = 246
  - MXSS = 375
  - MXPS = 375
- *CALPOST (modified params.pst):*
  - MXGX = 306
  - MXGY = 246
  - MXSS = 375

Following these changes, updated executables for each program were also created using the Lahey-Fujitsu FORTRAN Express v7.1 compiler. These updated executables were used in this CALPUFF analysis. The updated parameter files are presented in the electronic archive submitted with this modeling analysis.

3. CALPUFF MODELING RESULTS

Table 3-1 and 3-2 presents the results of the refined CALPUFF analysis for both the current and future emission scenario at the Mosaic Uncle Sam Plant. These results are presented graphically for the Breton Wilderness Area in Figures 3-1 through 3-3. As shown, the 8th highest values for the future emission scenario is less than 0.5 dv at the Breton and Caney Creek Wilderness Areas for the three annual simulations: 2001, 2002 and 2003. Therefore, it is determined that following implementation of the emission control projects discussed within this report, emissions from BART-eligible emission units at the Mosaic Uncle Sam Plant will not have the potential to significantly contribute to visibility impairment at any Class I area.

Table 3-1. Modeling Results – Breton Wilderness Area

Day	Emission Scenario and Annual Simulation					
	Current Emissions			Future Emissions		
	2001	2002	2003	2001	2002	2003
1st Highest	2.614	2.784	1.787	0.869	0.885	0.595
2nd Highest	1.841	1.981	1.708	0.610	0.702	0.577
3rd Highest	1.588	1.918	1.617	0.528	0.623	0.416
4th Highest	1.492	1.740	1.191	0.497	0.596	0.401
5th Highest	1.355	1.724	1.185	0.442	0.529	0.371
6th Highest	1.355	1.699	1.167	0.440	0.486	0.346
7th Highest	1.312	1.537	1.149	0.419	0.464	0.345
8th Highest (98th Percentile)	1.241	1.525	1.030	0.411	0.462	0.317

Table 3-2. Modeling Results – Caney Creek Wilderness Area

Day	Emission Scenario and Annual Simulation					
	Current Emissions			Future Emissions		
	2001	2002	2003	2001	2002	2003
1st Highest	0.383	0.474	0.625	0.161	0.132	0.182
2nd Highest	0.319	0.392	0.450	0.109	0.109	0.132
3rd Highest	0.314	0.314	0.329	0.097	0.088	0.091
4th Highest	0.281	0.270	0.267	0.090	0.083	0.077
5th Highest	0.276	0.252	0.250	0.089	0.072	0.075
6th Highest	0.272	0.219	0.246	0.087	0.071	0.069
7th Highest	0.268	0.210	0.212	0.079	0.062	0.063
8th Highest (98th Percentile)	0.258	0.203	0.204	0.076	0.057	0.062

Figure 3-1. Modeling Results, Breton Wilderness Area, 2001

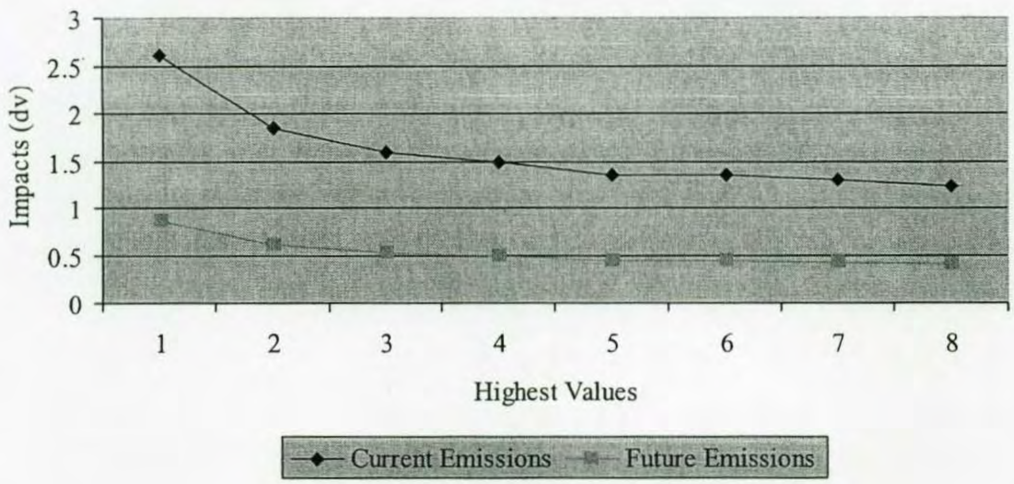


Figure 3-2. Modeling Results, Breton Wilderness Area, 2002

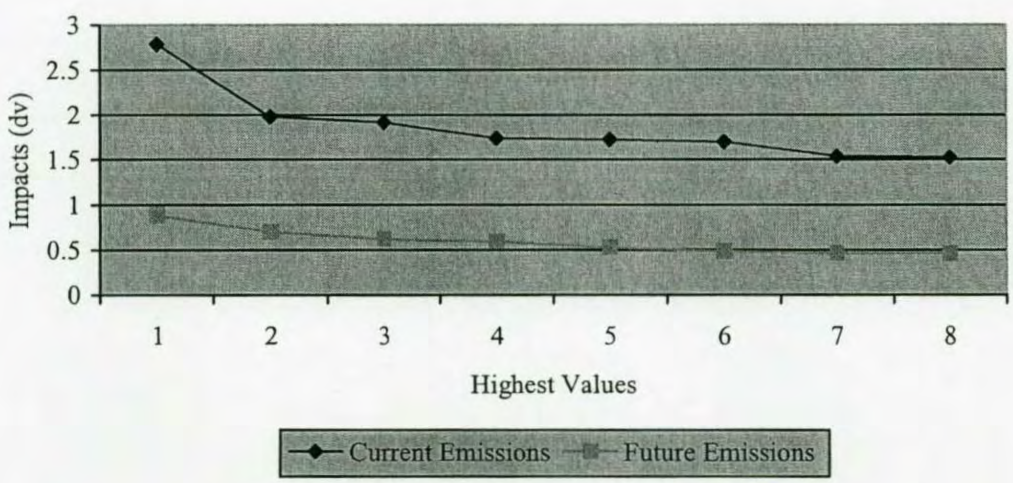
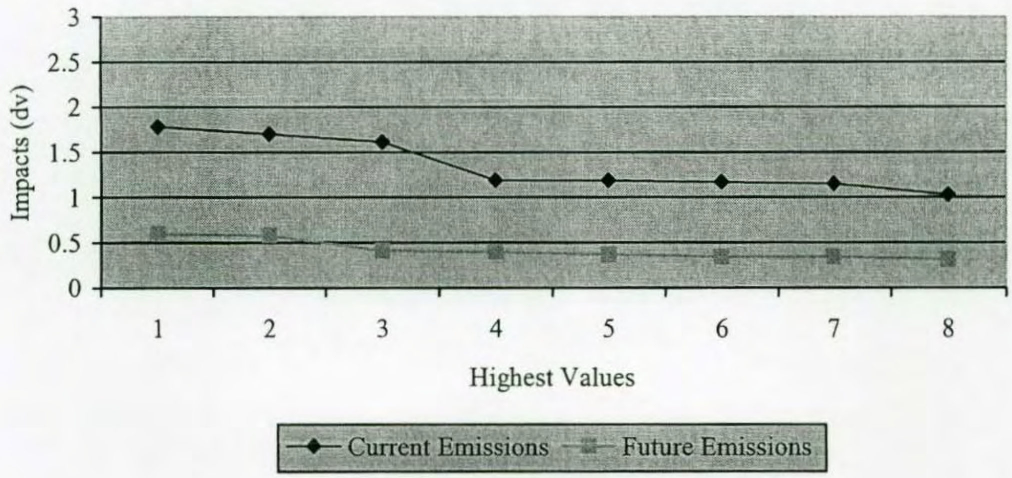


Figure 3-3. Modeling Results, Breton Wilderness Area, 2003



An archive of modeling files is included as Attachment G. Within the attachment are disks with electronic copies of model input and output files used and created in the modeling analysis. Also included is a table explaining the file naming convention.

ATTACHMENT A

Approved Modeling Protocol

Mosaic

Mosaic Fertilizer LLC
7250 Highway 44
Uncle Sam, LA 70792
www.mosaicco.com

Tel 225-562-3501
Fax 225-562-2760

LDEQ RECEIPT

2007 MAY 29 PM 1 24

May 25, 2007

HAND DELIVERED

Ms. Yvette McGehee
ECS Staff
Office of Environmental Assessment
Engineering Support Group
Louisiana Department of Environmental Quality
P.O. Box 4314
Baton Rouge, LA 70821-4314

**SUBJECT: Best Available Retrofit Technology Modeling Protocol Source-Specific, Subject-to-BART Refined Modeling Analysis
Mosaic Fertilizer LLC, Uncle Sam Plant
Agency Interest No. 2532**

Dear Ms. McGehee:

Mosaic Fertilizer LLC (Mosaic) is submitting this protocol to perform a source-specific, subject-to-BART refined modeling analysis for its Uncle Sam Plant. Mosaic will be performing this BART modeling analysis using CALPUFF for the Uncle Sam Plant in accordance with the Louisiana Department of Environmental Quality (LDEQ) March 1, 2007 request. The proposed modeling protocol to be used in Mosaic's Uncle Sam source-specific BART refined modeling analysis is enclosed for your review and approval.

Please contact me if you have any questions or need additional information at (225) 562-2773.

Sincerely,

Julie Roussel
Environmental Superintendent – LA Operations

Attachments

US:2.31

S:\Environmental\AIR\BART Modeling Project 2007

Best Available Retrofit Technology Modeling Protocol

Mosaic Fertilizer LLC
Uncle Sam Plant
AI Number 2532

Prepared for:

Mosaic Fertilizer LLC
St. James, Louisiana

Prepared by:

ENVIRON International Corporation

May 2007
Project No. 26-18160A

BEST AVAILABLE RETROFIT TECHNOLOGY MODELING PROTOCOL
SOURCE-SPECIFIC BART REFINED MODELING ANALYSIS
MOSAIC UNCLE SAM PLANT

Mosaic Fertilizer LLC (Mosaic) will be performing a source-specific BART modeling analysis using CALPUFF for the Uncle Sam Plant in accordance with the Louisiana Department of Environmental Quality (LDEQ) March 1, 2007 request. The proposed modeling protocol to be used in this source-specific BART refined modeling analysis is contained in this document. The proposed modeling protocol is based on the LDEQ Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana and Central States Regional Air Planning Association (CENRAP) guidance.[1,2]

I. Introduction

In 1999, the EPA promulgated rules to address visibility impairment – often referred to as "regional haze" – at designated federal Class I areas. These include areas such as national parks and wilderness areas where visibility is considered to be an important part of the visitor experience.[3] There is one Class I area in Louisiana – Breton Wilderness Area – as well as a number in surrounding states in close proximity to Louisiana. Guidelines providing direction to the states for implementing the regional haze rules were issued by EPA in July 2005. Affected states, including Louisiana, are required to develop plans for addressing visibility impairment. This includes a requirement that certain existing sources be equipped with Best Available Retrofit Technology, or BART. Louisiana is required to submit a regional haze plan to EPA no later than December 17, 2007.

[1] Louisiana Department of Environmental Quality (LDEQ). February 2007. *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana.*
[2] Alpine Geophysics, LLC. 2005. *CENRAP BART Modeling Guidelines.*

[3] U.S. Environmental Protection Agency (USEPA). 2005. Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations; Final Rule. Fed. Reg. 40 (July 6):39157. (40 CFR 51, Subpart P)

II. Background

BART guidance identifies potentially affected sources as those:

- Belonging to one of 26 industry source categories;[4]
- Having the potential to emit (PTE) 250 tons per year or more of any visibility-impairing pollutant; and
- Not in operation prior to August 7, 1962, and in existence on August 7, 1977.

Based on results of a CALPUFF model screening analysis performed by the LDEQ, 28 facilities in Louisiana were identified as potentially BART-eligible. These facilities were sent letters indicating that these facilities should perform detailed CALPUFF screening or refined modeling to evaluate if they impact a Class I area by at least 0.5-deciview or more.

III. BART Air Quality Modeling Approach

LDEQ has adopted one of the air quality modeling approaches in EPA's BART guidance which is an individual source attribution approach. Specifically, this entails modeling source-specific BART-eligible units and comparing modeled impacts to the deciview threshold. The modeling approach discussed here is specifically designed for conducting a source-specific BART refined modeling analysis.

[4] (1) fossil fuel-fired steam electric plants of more than 250 MMBtu/hour heat input; (2) coal-cleaning plants (thermal dryers); (3) Kraft pulp mills; (4) Portland cement plants; (5) primary zinc smelters; (6) iron and steel mill plants; (7) primary aluminum ore reduction plants; (8) primary copper smelters; (9) municipal incinerators capable of charging more than 250 tons of refuse per day; (10) hydrofluoric, sulfuric, and nitric acid plants; (11) petroleum refineries; (12) lime plants; (13) phosphate rock processing plants; (14) coke oven batteries; (15) sulfur recovery plants; (16) carbon black plants (furnace process); (17) primary lead smelters; (18) fuel conversion plants; (19) sintering plants; (20) secondary metal production facilities; (21) chemical process plants; (22) fossil fuel-fired boilers of more than 250 MMBtu/hour heat input; (23) petroleum storage and transfer facilities with capacity exceeding 300,000 barrels; (24) taconite ore processing facilities; (25) glass fiber processing plants; and (26) charcoal production facilities.

IV. Class I Areas to Assess

The list of Class I Areas to be included in this refined modeling analysis is presented in Table 1. All listed Class I Areas are located within the CENRAP South CALPUFF Domain.

Table 1 - Class I Areas Evaluated for BART in the CENRAP South CALPUFF Domain

Class I Area	State	Visibility Monitoring Site Name
Breton Wilderness Area	LA	BRET1
Caney Creek Wilderness Area	AR	CACR1

The Mosaic Uncle Sam Plant is located approximately 180 km from Breton Wilderness Area, the closest Class I Area. There are no other Class I Areas located within 300 km of the Mosaic Uncle Sam Plant. The next closest Class I Area is Caney Creek Wilderness Area, which is located 560 km from the facility. Based on discussions with LDEQ and the FLM, Mosaic will include the Caney Creek Wilderness Area to determine visibility impacts at this distant Class I Area.

V. Air Quality Model and Inputs

According to the final Regional Haze Rule's BART guidance, a source "can use CALPUFF 5.711a or other appropriate model to predict the visibility impacts from a single source at a Class I area." For purposes of this BART refined modeling analysis, Mosaic will use CALPUFF 5.711a.

A. Modeling Domain

The CALPUFF refined modeling analysis will be conducted on a subset of the CENRAP south domain. Mosaic will use 6 km grid spacing. The domain will extend at least 50 km to the east and south of Breton Wilderness Area and at least 50 km to the north and west of Caney Creek Wilderness Area. Proposed domain extents are as follows (Lambert Conformal Projection Coordinates):

- SW Corner (1,1): 180.0 km, -1188.0 km
- NX, NY: 108, 120

- DX, DY: 6 km, 6 km

CALPUFF will be applied for three annual simulations spanning the years 2001 through 2003.

B. CALPUFF System Implementation

There are three main components to the CALPUFF model:

1. Meteorological Data Modeling (CALMET);
2. Dispersion Modeling (CALPUFF); and
3. Post-processing (CALPOST).

Versions of the modeling components that will be used in the source-specific subject-to-BART refined modeling analysis are presented in Table 2.

Table 2 - CALPUFF Modeling Components

PROCESSOR	VERSION	LEVEL
TERREL	3.311	030709
CTGCOMP	2.42	030709
CTGPROC	2.42	030709
MAKEGEO	2.22	030709
CALMM5	2.4	050413
CALMET	5.53A	040716
CALPUFF	5.711A	040716
POSTUTIL	1.3	030402
CALPOST	5.51	030709

C. Meteorological Data Modeling (CALMET)

LDEQ guidance recommends using the 2001-2003 CENRAP-developed CALMET dataset in source-specific subject-to-BART screening analyses. Because observational data was not used in the CALMET outputs developed by CENRAP, the prognostic meteorological dataset from MM5 was not supplemented with surface or upper air observations during the CALMET processing. However, in their review of the draft CENRAP guidelines, both the EPA and Federal Land Managers (FLMs) commented that observations should be used in refined CALPUFF modeling. Because Mosaic is performing a refined modeling analysis, Mosaic will incorporate observational data during the CALMET processing.

Mosaic will obtain the CALMM5 dataset from CENRAP for use in creating the CALMET outputs. The CALMET outputs will consist of 10 vertical layers (11 layer interfaces). The top interface in the CALMET simulation will be 4,000 meters. Also, Mosaic will process surface, precipitation, and upper air observational data for use in CALMET. Meteorological stations will be selected from within the CENRAP south domain. Only those upper air stations in Louisiana and Mississippi that are within the focused domain will be selected for use in CALMET processing.

D. Stack Parameters

Stack parameters required for modeling BART-eligible units are: height of the stack opening from ground, inside stack diameter, exit gas flow rate, exit gas temperature, base elevation above sea level, and location coordinates of the stack.

Since BART modeling is concerned with long-range transport, not localized impacts, the effects of building downwash will be not incorporated into the Mosaic Uncle Same Plant modeling analysis.

E. Emissions

Emission rates for the BART analyses follow EPA's BART guidance. Specifically, the 24-hour average actual emission rate from the highest emitting day of the year under normal operations will be modeled. Identification of the maximum 24-hour actual emission rate will be made for each of the most recent three (3) years (2001-2003), according to the following prioritization:

1. Continuous Emissions Monitoring data;
2. Facility emissions tests;
3. Emissions factors;
4. Permit limits; or lastly,

5. Potential to emit.

The species that should be modeled and/or emitted in the source-specific subject-to-BART refined analysis are listed in Table 3.

Table 3 - Species Modeled in BART Refined Analysis

Species	Modeled	Emitted	Dry Deposited
SO_2	Yes	Yes	Computed-gas
SO_4	Yes	No	Computed-particle
NO_X	Yes	Yes	Computed-gas
HNO_3	Yes	No	Computed-gas
NO_3	Yes	No	Computed-particle
EC	Yes	Yes	Computed-particle
OC (SOA)	Yes	Yes	Computed-particle
PM-fine ($PM_{2.5}$)	Yes	Yes	Computed-particle
PM-coarse ($PM_{10-2.5}$)	Yes	Yes	Computed-particle

Particle size parameters are entered in the CALPUFF input file for dry deposition of particles. The default value for "aerosol" species (e.g., SO_4, NO_3, and $PM_{2.5}$) is 0.48 μm geometric mass mean diameter and 2.0 μm geometric standard deviation. Mosaic will use either the default values or site-specific data for the aerosol species.

F. Dispersion Model (CALPUFF)

The CALMET output is used as input to the CALPUFF model, which simulates the effects of meteorological conditions on the transport and dispersion of pollutants from an individual source. In general, the default options will be used in the CALPUFF model for this refined analysis. However, Mosaic will employ the puff-splitting option, which splits puffs that become large over greater transport distances.

Ozone and ammonia concentrations

Ozone (O_3) and ammonia (NH_3) can be input to CALPUFF as either hourly or monthly background values. Background hourly O_3 concentrations will be derived from regional model simulations obtained from CENRAP. NH_3 concentrations are assumed to be temporally and spatially invariant and will be fixed at 3 ppb across the entire domain for all months.

Receptors

Receptors are locations where model results are calculated and provided in the CALPUFF output files. Receptor locations will be derived from the National Park Service (NPS) Class I area receptor database.[5] The receptors will be kept at the one (1) km spacing as provided by the NPS.

Outputs

The CALPUFF modeling results will be displayed in units of micrograms per cubic meter ($\mu g/m^3$). CALPUFF outputs will be post-processed to determine visibility impacts.

G. Post-processing (CALPOST)

Hourly concentration outputs from CALPUFF are processed through POSTUTIL and CALPOST to determine visibility conditions. POSTUTIL takes the concentration file output from CALPUFF and recalculates the nitric acid and nitrate partition based on total

[5] http://www2.nature.nps.gov/air/maps/receptors/index.cfm.

available sulfate and ammonia. CALPOST uses the concentration file processed through POSTUTIL, along with relative humidity data, to perform visibility calculations. For the source-specific BART refined modeling analysis, the only modeling results of interest out of the CALPUFF modeling system are the visibility impacts.

Light Extinction

Light extinction must be computed in order to calculate visibility. CALPOST has seven (7) methods for computing light extinction. Mosaic will use Method 6, which computes extinction from speciated particulate matter with monthly Class I area-specific relative humidity adjustment factors. The BART refined analysis will apply relative humidity correction factors [*f*(RH)s] to sulfate and nitrate concentration outputs from CALPUFF. Relative humidity correction factors will be obtained from EPA's "Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule."[6] The $PM_{2.5}$ concentrations are considered part of the dry light extinction equation and do not have a humidity adjustment factor. The light extinction equation is the sum of the wet sulfate and nitrate and dry components ($PM_{2.5}$ plus Rayleigh scattering), which is 10 inverse megameters (Mm^{-1})

VI. Visibility Impacts

Perceived visibility in deciviews is derived from the light extinction coefficient. The visibility change related to background is calculated using the modeled and established natural visibility conditions. For the BART refined modeling analysis, daily visibility will be expressed as a change in deciviews compared to natural visibility conditions. Natural visibility conditions will be based on the annual average natural levels of aerosol components at each Class I area, which are taken from the EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule."[7]

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[6] U.S. EPA (September 2003). *Regional Haze: Estimating Natural Visibility Conditions Under the Regional Haze Rule*. EPA-454/B-03-005.
[7] Ibid.

Mosaic will process the CALPOST visibility impacts in deciviews in a spreadsheet to calculate the changes in deciviews (del-dv). These del-dv values will be ranked for each of three years at each Class I area. The 98th percentile (8th highest value) in the sorted table will be compared to the contribution threshold (e.g., 0.5 dv). If the source passes the refined analysis because the highest 98th percentile visibility impact is below the contribution threshold of 0.5 dv, then the source is exempt from further BART requirements. However, if the highest 98th percentile visibility impact is at or above the contribution threshold of 0.5 dv, then Mosaic will perform a BART engineering analysis, which includes analysis of the change in visibility due to BART controls.

VII. Change in Visibility Due to BART Controls

If necessary, Mosaic will perform a BART engineering analysis and establish BART emission limits. Following that, additional CALPUFF modeling will be conducted to establish visibility improvement at Class I areas with BART applied. The post-control CALPUFF simulations will be compared to the pre-control CALPUFF simulation by calculating the change in visibility over natural conditions between the pre-control and post-control simulations.

VIII. Reporting

As required, this modeling protocol for refined CALPUFF modeling is being submitted to the LDEQ for approval. This protocol will also be made available to EPA Region VI personnel, FLMs (Tim Allen of Fish and Wildlife Service and Judy Logan of Forest Service), and Arkansas Department of Environmental Quality personnel for their review.

A. Modeling Results Submittal

Mosaic will submit a final modeling report detailing the modeling procedures and results for the source-specific BART refined modeling analysis. Mosaic will also provide an electronic archive that includes the full set of CALPUFF inputs and model output fields.

B. Contact Information

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ATTACHMENT B

CALMET Control File Inputs

Parameter	Description	CALMET Default	CALMET Inputs	Comments	Source
NUSTA	Number of upper air stations	N.A.	16	CENRAP South Domain	2
NOWSTA	Number of over water met stations	N.A.	7	Western Gulf of Mexico	2
IBYR	Starting year	N.A.	2001 (2002 and 2003 also modeled)		1
IBMO	Starting month	N.A.	1		1
IBDY	Starting day	N.A.	1		1
IBHR	Starting hour	N.A.	0	CALMM5 data developed in GMT; therefore, CALMET starting hour must correspond to CALMM5 starting hour	2
IBTZ	Base time zone	N.A.	0	CALMM5 data developed in GMT	2
IRLG	Length of run	N.A.	8760 (2002 - 8760, 2003 - 8748)		1
IRTYPE	Run type (must = 1 to run CALPUFF)	1	1		1
LCALGRD	Compute CALGRID data fields	T	F	Revised per CENRAP guidance	1
ITEST	Stop run after SETUP to do input QA	2	2		1
PMAP	Map Projection	UTM	LCC	Revised per CENRAP guidance	1
RLATO	Latitude (dec. degrees) of projection origin	N.A.	40N		1
RLONO	Longitude (dec. degrees) of projection origin	N.A.	97W		1
XLAT1	Matching parallel(s) of latitude for projection	N.A.	33N		1
XLAT2	Matching parallel(s) of latitude for projection	N.A.	45N		1
DATUM		WGS-G	WGS-G		1
NX	Number of X grid cells in meteorological grid	N.A.	306		1
NY	Number of Y grid cells in meteorological grid	N.A.	246		1
DGRIDKM	Grid spacing, km	N.A.	6		1
XORIGKM	Ref. Coordinate of SW corner of grid cell (1,1)	N.A.	-1008		1
YORIGKM	Ref. Coordinate of SW corner of grid cell (1,1)	N.A.	-1620		1
NZ	No. of vertical layers	N.A.	10		1
ZFACE	Cell face heights in arbitrary vertical grid, m	N.A.	0,20,40,80,160,320,640,1200,2000,3000,4000		1
LSAVE	Disk output option	T	T		1
IFORMO	Type of unformatted output file	1	1		1
LPRINT	Print met fields	F	F		1
IPRINF	Print intervals	1	1		1
IUVOUT(NZ)	Specify layers of u,v wind components to print	NZ*0	NZ*0		1
IWOUT(NZ)	Specify layers of w wind component to print	NZ*0	NZ*0		1
ITOUT(NZ)	Specify levels of 3-D temperature field to print	NZ*0	NZ*0		1
LDB	Print input met data and variables.	F	F		1
NN1	First time step for debug data and variables	1	1		1
NN2	Last time step for debug data to be printed	1	1		1
IOUTD	Control variable for writing test/debug wind fields	0	0		1
NZPRN2	Number of levels starting at surface to print	1	0	Revised per CENRAP guidance	1
IPR0	Print interpolated wind components	0	0		1
IPR1	Print terrain adjusted surface wind components	0	0		1
IPR2	Print initial divergence fields	0	0		1
IPR3	Print final wind speed and direction	0	0		1
IPR4	Print final divergence fields	0	0		1
IPR5	Print winds after kinematic effects	0	0		1
IPR6	Print winds after Froude number adjustment	0	0		1
IPR7	Print winds after slope flows are added	0	0		1
IPR8	Print final wind field components	0	0		1
NOOBS	0=surface, overwater, or upper air observations	0	0		2
NSSTA	Number of meteorological surface stations	N.A.	347 (2002 - 351, 2003 - 375)		2
NPSTA	Number of precipitation stations	N.A.	347 (2002 - 351, 2003 - 375)		2
ICLOUD	Gridded cloud fields	0	0		3
IFORMS	Formatted surface meteorological data file	2	2		1,3
IFORMP	Formatted surface precipitation data file	2	2		1,3
IFORMC	Formatted cloud data file	2	2		1,3
IWFCOD	Model selection variable	1	1		1,3
IFRADJ	Compute Froude number adjustment effects?	1	1		1,3
IKINE	Compute kinematic effects?	0	0		1,3
IOBR	Use O'Brien (1970) vertical velocity adjustment?	0	0		1,3
ISLSOPE	Compute slope flow effects?	1	1		1,3
IEXTRP	Extrapolate surface wind obs to upper levels?	-4	-4		3
ICALM	Extrapolate surface winds even if calm?	0	0		1,3
BIAS	Layer-dependent biases weighting aloft measurements	NZ*0	0,0,0,0,0,0,0,0,0,0		1,3
RMIN2	Minimum vertical extrapolation distance	4	4		1,3
IPROG	14=Yes, use winds from MM5.DAT file as initial guess field [IWFCOD=1	0	14	Revised per CENRAP guidance	2
ISTEPPG	MM5 output timestep	1	1		1
LVARY	Use varying radius of influence	F	F	Use CALMET default	n.a.
RMAX1	Maximum radius of influence over land in sfc layer	N.A.	30		1
RMAX2	Maximum radius of influence over land aloft	N.A.	60		1

Parameter	Description	CALMET Default	CALMET Inputs	Comments	Source
RMAX3	Maximum radius of influence over water	N.A.	50		1
RMIN	Minimum radius of influence used anywhere	0.1	0.1		1,3
TERRAD	Terrain features radius of influence	N.A.	12		1
R1	Weighting of first guess surface field	N.A.	6 (2002 and 2003 - 18)		2
R2	Weighting of first guess aloft field	N.A.	12 (2002 and 2003 - 36)		2
RPROG	MM5 windfield weighting parameter	N.A.	0		1
DIVLIM	Minimum divergence criterion	5 E -6	5 E -6		1,3
NITER	Number of divergence minimization iterations	50	50		1,3
NSMMTH	Number of passes through smoothing filter in each layer of CALMET	2,4,4,4,4,4,4	2,4,4,4,4,4,4		1,3
NITR2	Maximum number of stations used in each layer for the interpolation of data to a grid point	99	99		3
CRITFN	Critical Froude number	1	1		1,3
ALPHA	Kinematic effects parameter	0.1	0.1		1,3
FEXTR2	Scaling factor for extrapolating sfc winds aloft	NZ*0.0	NZ*0.0		1
NBAR	Number of terrain barriers	0	0		1
IDIOTP1	Surface temperature computation switch	0	0		1,3
ISURFT	Number of sfc met stations to use for temp. calcs.	N.A.	1		2
IDIOTP2	Domain-averaged lapse rate switch	0	0		1,3
IUPT	Upper air stations to use for lapse rate calculation	0	1	User Specified Value	2
ZUPT	Depth through which lapse rate is calculated	200	200		1,3
IDIOPT3	Domain-averaged wind component switch	0	0		1,3
IUPWND	Number of aloft stations to use for wind calc.	-1	-1		1,3
ZUPWND(1)	Bottom and top of layer through which the domain-scale winds are computed	1	1		1,3
ZUPWND(2)		1000	1000		1,3
IDIOPT4	Observed surface wind component switch	0	0		1,3
IDIOPT5	Observed aloft wind component switch	0	0		1,3
LLBREZE	Use Lake Breeze Module	F	F		1
NBOX	Number of lake breeze regions	0	0		1
NLB	Number of stations in the region	N.A.	0		1
METBXID(NLB)	Station ID's in the region	N.A.	0		1
CONSTB	Neutral stability mixing height coefficient	1.41	1.41		1,3
CONSTE	Convective stability mixing height coefficient	0.15	0.15		1,3
CONSTN	Stable stability mixing height coefficient	2400	2400		1,3
CONSTW	Overwater mixing height coefficient	0.16	0.16		1,3
FCORIOL	Absolute value of Coriolis parameter	1 E -4	1 E -4		1,3
IAVEZI	Conduct spatial averaging? Yes = 1	1	1		1,3
MNMDAV	Maximum search radius in averaging process	1	10		1
HAFANG	Half-angle of upwind looking cone for averaging	30	30		1,3
ILEVZI	Layers of wind use in upwind averaging	1	1		1,3
DPTMIN	Minimum potential temperature lapse rate in the stable layer above the current convective mixing height	0.001	0.001		1,3
DZZI	Depth of layer above current conv., mixing height through which lapse rate is computed	200	200		1,3
ZIMIN	Minimum overland mixing height	50	50		1,3
ZIMAX	Maximum overland mixing height	3000	3000		1,3
ZIMINW	Minimum overwater mixing height	50	50		1,3
ZIMAXW	Maximum overwater mixing height	3000	3000		1,3
ITPROG	3D temperature from observations or from MM5?	0	0		2
IRAD	Type of interpolation; 1= 1/R	1	1		1,3
TRADKM	Temperature interpolation radius of influence	500	500		3
NUMTS	Max. number of stations for temp interpolation	5	5		1,3
IAVET	Spatially average temperatures? 1= yes	1	0	Per internal ENVIRON expert guidance (Ralph Morris), value needs to be 0	2
TGDEFB	Temp gradient below mixing height over water	-0.0098	-0.0098		1,3
TGDEFA	Temp gradient above mixing height over water	-0.0045	-0.0045		1,3
JWAT1	Beginning land use categories over water	N.A.	55		1
JWAT2	Ending land use categories for water	N.A.	55		1
NFLAGP	Precipitation interpolation flag; 2 = 1/R squared	2	2		1,3
SIGMAP	Radius of influence for precipitation interpolation	100	100		3
CUTP	Minimum precipitation rate cutoff (mm/hr)	0.01	0.01		1,3

Notes:

[1] CENRAP, CENRAP BART Modeling Guidelines, December 2005

[2] User-specified input based on CENRAP guidance

[3] USEPA, IWAQM Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts

ATTACHMENT C

Surface and Precipitation Stations

Table B-1. CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K4BL	3	-1088.794	-188.74
K4CR	4	-796.753	-614.946
K4MY	5	-820.552	-514.181
K6R6	6	-504.682	-1089.929
KAAO	7	-19.239	-248.771
KABI	8	-252.073	-836.385
KABQ	9	-870.967	-501.552
KACT	10	-20.572	-929.193
KADH	11	30.04	-574.23
KADS	12	15.55	-778.91
KAEG	13	-886.431	-489.863
KAEX	14	424.008	-951.083
KAFW	15	-29.84	-864.178
KAIZ	16	387.096	-200.609
KALI	17	-103.042	-1363.706
KALM	18	-839.633	-752.147
KALN	19	597.6	-100.613
KALS	20	-777.382	-244.023
KAMA	21	-425.225	-516.367
KARA	22	495.794	-1092.463
KARG	23	543.544	-409.481
KASD	24	691.97	-1044.068
KASG	25	257.655	-419.895
KATS	26	-699.341	-756.355
KATT	27	-67.189	-1077.024
KAUS	28	-64.44	-1085.31
KBAZ	29	-102.133	-1140.919
KBFM	30	857.496	-996.792
KBGD	31	-395.603	-466.083
KBLV	32	617.659	-136.018
KBMG	33	888.591	-45.013
KBMQ	34	-118.107	-1027.37
KBNA	35	920.716	-377.2
KBPK	36	404.476	-391.372
KBPT	37	289.282	-1110.638
KBRO	38	-44.198	-1571.387
KBTR	39	562.77	-1032.028
KBVE	40	741.254	-1153.502
KBVO	41	88.664	-358.933
KBVX	42	480.71	-457.819
KCAO	43	-547.124	-374.102
KCDS	44	-300.324	-610.634
KCEZ	45	-1020.893	-233.136
KCFV	46	126.511	-320.682
KCGI	47	652.519	-279.306

Table B-1. CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KCLL	48	60.926	-1044.347
KCNK	49	-55.418	-49.561
KCNM	50	-682.759	-822.078
KCNU	51	132.781	-256.9
KCNY	52	-1095.593	-59.385
KCOS	53	-663.999	-102.631
KCOT	54	-219.067	-1280.964
KCOU	55	411.894	-119.997
KCPS	56	591.654	-136.172
KCQC	57	-775.182	-516.728
KCRP	58	-49.841	-1360.392
KCRS	59	56.76	-882.852
KCSM	60	-198.798	-512.028
KCVN	61	-556.268	-599.276
KCVS	62	-577.834	-601.516
KCXO	63	153.025	-1068.554
KDAL	64	14.014	-791.889
KDCU	65	915.854	-541.281
KDDC	66	-259.327	-242.715
KDFW	67	-3.109	-786.339
KDHT	68	-496.517	-424.942
KDLF	69	-369.535	-1173.036
KDMN	70	-1006.923	-798.125
KDMO	71	336.438	-136.522
KDRO	72	-945.713	-259.162
KDRT	73	-382.557	-1172.484
KDTN	74	304.839	-822.047
KDTO	75	-18.599	-752.969
KDWH	76	140.407	-1100.838
KDYR	77	679.855	-412.145
KEAX	78	235.703	-128.032
KEFD	79	178.542	-1150.911
KEHA	80	-431.288	-320.167
KEHR	81	812.8	-199.338
KELP	82	-888.697	-862.785
KEMP	83	69.39	-183.984
KEND	84	-81.725	-403.278
KEVV	85	822.902	-172.718
KEWK	86	-24.383	-215.58
KF39	87	30.792	-697.387
KFAM	88	573.877	-225.83
KFDR	89	-181.762	-623.071
KFLP	90	404.266	-399.14
KFMN	91	-993.475	-297.941
KFOE	92	114.644	-115.26
KFSM	93	237.996	-512.835
KFST	94	-566.391	-988.873
KFTW	95	-32.713	-795.542

Table B-1. CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFWD	96	-27.846	-793.612
KFYV	97	253.764	-438.483
KGAG	98	-246.79	-405.469
KGBD	99	-162.152	-180.775
KGCK	100	-324.1	-221.895
KGDP	101	-737.521	-873.407
KGGG	102	214.599	-841.127
KGKY	103	-8.972	-812.595
KGLD	104	-401.583	-59.64
KGLH	105	557.042	-703.065
KGLS	106	208.675	-1189.492
KGNT	107	-985.121	-475.597
KGOK	108	-37.305	-458.997
KGPM	109	-4.681	-808.583
KGPT	110	764.04	-1031.678
KGTR	111	779.037	-689.11
KGTU	112	-65.338	-1033.51
KGUC	113	-855.846	-113.585
KGUP	114	-1060.45	-427.996
KGUY	115	-399.88	-356.694
KGWO	116	640.075	-695.287
KHBG	117	737.58	-936.506
KHBR	118	-186.121	-551.122
KHDO	119	-211.719	-1180.077
KHEZ	120	545.517	-911.954
KHGX	121	187.376	-1166.957
KHKA	122	642.067	-423.71
KHKS	123	636.926	-825.191
KHLC	124	-242.098	-64.417
KHNB	125	870.668	-145.447
KHOP	126	841.754	-324.602
KHOT	127	356.463	-602.864
KHOU	128	167.118	-1147.403
KHRL	129	-67.728	-1533.473
KHRO	130	343.012	-405.722
KHUM	131	616.723	-1136.814
KHUT	132	-75.456	-213.411
KHYI	133	-84.429	-1120.581
KHYS	134	-195.165	-124.724
KIAB	135	-23.366	-263.504
KIAH	136	159.982	-1112.067
KICT	137	-36.491	-259.771
KIER	138	369.594	-908.657
KILE	139	-65.316	-988.473
KINK	140	-586.879	-890.621
KITR	141	-451.837	-69.8
KIXD	142	180.857	-126.914
KJAN	143	650.08	-826.487

Table B-1. CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KJBR	144	569.655	-440.988
KJCT	145	-264.805	-1049.863
KJEF	146	417.469	-143.696
KJLN	147	220.368	-310.284
KLAA	148	-494.483	-198.304
KLAW	149	-129.378	-600.254
KLBB	150	-445.079	-691.2
KLBL	151	-350.15	-318.583
KLBX	152	150.63	-1207.65
KLCH	153	366.039	-1089.113
KLFK	154	214.642	-969.288
KLFT	155	483.139	-1074.12
KLHX	156	-567.01	-195.279
KLIC	157	-573.7	-69.147
KLIT	158	434.161	-571.401
KLIX	159	691.695	-1044.752
KLLQ	160	485.203	-691.199
KLRD	161	-246.569	-1383.486
KLRF	162	440.656	-550.693
KLRU	163	-917.261	-803.759
KLSX	164	544.697	-124.925
KLVJ	165	172.567	-1160.745
KLVS	166	-731.441	-447.785
KLWC	167	153.636	-108.143
KLWV	168	809.107	-95.154
KMAF	169	-489.696	-878.105
KMCB	170	622.67	-955.341
KMCI	171	195.298	-73.101
KMDH	172	676.591	-216.245
KMEG	173	651.863	-512.89
KMEI	174	774.908	-814.191
KMEM	175	634.534	-523.229
KMFE	176	-125.361	-1538.535
KMHK	177	28.579	-93.934
KMKC	178	205.861	-94.951
KMKL	179	727.077	-454.381
KMKO	180	146.966	-478.029
KMLC	181	110.644	-565.417
KMOB	182	839.42	-992.943
KMRF	183	-676.239	-1042.652
KMSL	184	853.332	-536.843
KMSY	185	653.767	-1087.37
KMTJ	186	-939.546	-109.53
KMVN	187	704.695	-154.57
KMWA	188	698.685	-218.021
KMWL	189	-99.741	-798.734
KNEW	190	674.286	-1080.207
KNGP	191	-28.264	-1368

Table B-1. CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KNQA	192	643.986	-489.146
KOCH	193	216.534	-930.592
KODO	194	-509.4	-880.305
KOJC	195	180.815	-125.068
KOKC	196	-54.186	-508.715
KOUN	197	-41.707	-526.861
KOWB	198	858.23	-202.317
KP28	199	-139.317	-297.355
KP92	200	557.13	-1172.603
KPAH	201	725.844	-291.476
KPBF	202	464.795	-631.204
KPIB	203	728.391	-915.201
KPIL	204	-33.55	-1540.831
KPNC	205	-8.868	-361.264
KPOF	206	591.592	-335.455
KPPF	207	130.459	-293.82
KPQL	208	814.856	-1019.221
KPRX	209	143.317	-703.629
KPSX	210	73.879	-1253.364
KPTN	211	551.151	-1123.941
KPUB	212	-651.703	-162.851
KPWA	213	-57.09	-493.927
KPWG	214	-30.433	-944.406
KRBD	215	12.481	-810.433
KRKP	216	-4.965	-1324.879
KRND	217	-125.115	-1161.171
KROG	218	258.441	-397.719
KROW	219	-698.85	-712.895
KRQE	220	-1083.18	-409.162
KRSL	221	-156.389	-123.748
KRSN	222	413.677	-819.685
KRTN	223	-664.239	-331.996
KRUE	224	352.817	-517.944
KRVS	225	90.474	-437.23
KSAF	226	-816.558	-444.045
KSAT	227	-142.994	-1160.901
KSET	228	564.392	-97.842
KSGF	229	318.465	-299.61
KSGR	230	131.473	-1151.365
KSGT	231	495.691	-582.749
KSHV	232	298.831	-829.307
KSJT	233	-333.267	-950.677
KSKX	234	-812.696	-797.619
KSLG	235	224.802	-417.183
KSLN	236	-56.011	-132.485
KSPD	237	-493.802	-285.159
KSPS	238	-136.546	-666.72
KSRC	239	475.987	-516.167

Table B-1. CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KSRR	240	-789.624	-686.256
KSSF	241	-144.978	-1183.291
KSTL	242	570.065	-117.452
KSUS	243	549.336	-130.02
KSVC	244	-1043.578	-751.807
KSWO	245	-7.445	-423.979
KSZL	246	297.567	-136.247
KTAD	247	-645.048	-278.061
KTBN	248	423.924	-237.479
KTCC	249	-597.363	-511.501
KTCL	250	870.684	-704.299
KTCS	251	-952.322	-695.439
KTIK	252	-34.608	-506.971
KTKI	253	38.139	-755.127
KTOP	254	117.322	-102.315
KTPL	255	-39.799	-981.183
KTRL	256	68.48	-806.796
KTUL	257	98.267	-419.701
KTUP	258	753.906	-600.367
KTVR	259	560.687	-829.118
KTXK	260	278.022	-720.622
KTYR	261	150.418	-844.347
KUNO	262	450.268	-332.422
KUTS	263	136.314	-1024.869
KVBT	264	247.807	-399.9
KVCT	265	8.192	-1238.695
KVIH	266	454.952	-193.303
KWDG	267	-71.289	-399.691
KWLD	268	0	-320.695
KXNA	269	240.016	-407.886
MMCL	270	-1072.535	-1632.775
KCWF	271	371.999	-1077.296
KHOB	272	-580.048	-790.648
KPOE	273	364.89	-984.772
MMIO	274	-715.54	-1595.056
MMMY	275	-316.613	-1579.702
KGRK	276	-79.671	-990.206
KMLU	277	466.016	-816.792
KTEX	278	-948.259	-169.74
MMRX	279	-125.617	-1557.41
KESF	280	447.345	-943.674
KLZK	281	431.199	-560.297
KADM	282	-1.531	-630.847
MMNL	283	-257.222	-1394.843
KE33	284	-846.39	-298.154
MMAN	285	-329.872	-1569.4
MMCS	286	-893.759	-880.938
MMMA	287	-54.487	-1586.451

Table B-1. CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KMWT	288	312.521	-597.597
K4SL	289	-889.332	-391.854
KSKF	290	-154.653	-1177.521
KBIX	291	778.283	-1028.545
KCBM	292	789.252	-665.842
KDYS	293	-267.671	-834.062
KAFF	294	-671.158	-85.372
KLTS	295	-206.759	-589.446
KNBG	296	677.608	-1102.405
KBYH	297	631.187	-421.631
KHMN	298	-848.745	-749.371
KLAM	299	-831.464	-412.856
KNMM	300	789.841	-788.597
MMPG	301	-346.402	-1248.84
MMTC	302	-660.346	-1590.033
KFSI	303	-127.711	-591.042
KFCS	304	-669.55	-116.96
KNFW	305	-40.525	-801.069
KNQI	306	-81.68	-1390.219
KBAD	307	312.771	-825.1
KFRI	308	20.033	-105.018
KGVT	309	86.944	-767.36
KHLR	310	-68.45	-981.004
KELD	311	390.361	-742.112
MMCU	312	-882.35	-1211.961
MMMV	313	-444.934	-1449.379
KEPZ	314	-915.897	-851.724
KAVK	315	-148.023	-355.847
KGMJ	316	200.75	-372.417
KPVJ	317	-20.054	-585.348
KRKR	318	216.017	-548.175
KCKV	319	849.69	-329.329
KOLV	320	654.146	-529.476
KDEQ	321	239.058	-655.169
KSLO	322	692.8	-118.63
KWWR	323	-225.565	-391.327
KAQR	324	77.8	-619.389
KCHK	325	-87.955	-541.668
KCQB	326	16.186	-473.43
KDUA	327	56.176	-670.61
KDUC	328	-87.786	-611.524
KENL	329	683.539	-134.985
KFOA	330	735.051	-91.448
KFWC	331	743.489	-143.961
KGCM	332	135.617	-409.198
KGLE	333	-18.489	-702.977
KHSB	334	737.259	-207.858
KJSV	335	198.556	-502.06

Table B-1. CENRAP South Surface Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KJWG	336	-127.44	-456.946
KOKM	337	94.479	-478.439
KOLY	338	759.691	-104.636
KSAR	339	634.139	-179.076
KSNL	340	5.421	-513.325
KTQH	341	179.315	-448.216
K1H2	342	726.033	-68.974
KCPW	343	-858.907	-235.621
KMYP	344	-805.328	-126.737
KVTP	345	-715.975	-244.241
KHDC	346	632.988	-1028.708
KMNH	347	-652.817	-58.825

Table B-2. CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K4BL	3	-1088.794	-188.74
K4CR	4	-796.753	-614.946
K4MY	5	-820.552	-514.181
K4SL	6	-902.016	-397.882
K6R6	7	-504.682	-1089.929
KAAO	8	-19.239	-248.771
KABI	9	-252.073	-836.385
KABQ	10	-870.967	-501.552
KACT	11	-20.572	-929.193
KADH	12	30.04	-574.23
KADM	13	-1.531	-630.847
KADS	14	15.55	-778.91
KAEG	15	-886.431	-489.863
KAEX	16	424.008	-951.083
KAFW	17	-29.67	-778.139
KAIZ	18	387.096	-200.609
KALI	19	-102.174	-1362.836
KALM	20	-839.633	-752.147
KALN	21	597.6	-100.613
KALS	22	-777.382	-244.023
KAMA	23	-425.225	-516.367
KAQR	24	77.8	-619.389
KARA	25	495.794	-1092.463
KARG	26	543.544	-409.481
KASD	27	691.97	-1044.068
KASG	28	257.655	-419.895
KATS	29	-699.341	-756.355
KATT	30	-67.189	-1077.024
KAUS	31	-64.44	-1085.31
KAVK	32	-148.023	-355.847
KBAZ	33	-102.133	-1140.919
KBFM	34	857.496	-996.792
KBGD	35	-395.603	-466.083
KBMG	36	888.591	-45.013
KBMQ	37	-118.107	-1027.37
KBNA	38	920.716	-377.2
KBPK	39	404.476	-391.372
KBPT	40	289.282	-1110.638
KBRO	41	-44.198	-1571.387
KBTR	42	562.77	-1032.028
KBVE	43	741.254	-1153.502
KBVO	44	88.664	-358.933
KBVX	45	480.71	-457.819
KCAO	46	-547.124	-374.102
KCDS	47	-300.324	-610.634

Table B-2. CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KCEZ	48	-1020.893	-233.136
KCFV	49	126.511	-320.682
KCGI	50	652.519	-279.306
KCHK	51	-87.955	-541.668
KCKV	52	850.158	-329.28
KCLL	53	60.926	-1044.347
KCNK	54	-55.418	-49.561
KCNM	55	-681.361	-822.067
KCNU	56	132.781	-256.9
KCNY	57	-1095.593	-59.385
KCOS	58	-663.999	-102.631
KCOT	59	-219.079	-1280.593
KCOU	60	411.894	-119.997
KCPS	61	591.654	-136.172
KCQB	62	16.186	-473.43
KCQC	63	-775.182	-516.728
KCRP	64	-49.841	-1360.392
KCRS	65	56.76	-882.852
KCSM	66	-198.798	-512.028
KCVN	67	-556.268	-599.276
KCVS	68	-577.834	-601.516
KCXO	69	153.025	-1068.554
KDAL	70	14.014	-791.889
KDCU	71	915.854	-541.281
KDDC	72	-259.327	-242.715
KDEQ	73	238.943	-655.661
KDFW	74	-3.109	-786.339
KDHT	75	-496.517	-424.942
KDMN	76	-1006.923	-798.125
KDMO	77	336.438	-136.522
KDRO	78	-945.713	-259.162
KDRT	79	-382.557	-1172.484
KDTN	80	304.839	-822.047
KDTO	81	-18.599	-752.969
KDUA	82	56.176	-670.61
KDUC	83	-87.786	-611.524
KDWH	84	140.407	-1100.838
KDYR	85	679.855	-412.145
KEFD	86	178.542	-1150.911
KEHA	87	-431.288	-320.167
KEHR	88	812.8	-199.338
KELP	89	-888.697	-862.785
KEMP	90	69.39	-183.984
KENL	91	683.539	-134.985
KESF	92	447.345	-943.674
KEVV	93	822.902	-172.718
KEWK	94	-24.383	-215.58
KFAM	95	573.877	-225.83

Table B-2. CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFDR	96	-181.762	-623.071
KFLP	97	404.266	-399.14
KFMN	98	-993.475	-297.941
KFOA	99	735.051	-91.448
KFOE	100	114.644	-115.26
KFSM	101	237.996	-512.835
KFST	102	-566.391	-988.873
KFTW	103	-32.713	-795.542
KFWC	104	743.489	-143.961
KFWD	105	-27.846	-793.612
KFYV	106	253.764	-438.483
KGAG	107	-246.79	-405.469
KGBD	108	-162.152	-180.775
KGCK	109	-324.1	-221.895
KGCM	110	135.617	-409.198
KGDP	111	-737.521	-873.407
KGGG	112	214.599	-841.127
KGKY	113	-8.972	-812.595
KGLD	114	-401.583	-59.64
KGLE	115	-18.489	-702.977
KGLH	116	557.167	-701.877
KGLS	117	208.675	-1189.492
KGMJ	118	200.75	-372.417
KGNT	119	-985.121	-475.597
KGOK	120	-37.305	-458.997
KGPM	121	-4.681	-808.583
KGPT	122	764.04	-1031.678
KGRK	123	-79.671	-990.206
KGTR	124	779.037	-689.11
KGTU	125	-65.338	-1033.51
KGUC	126	-855.846	-113.585
KGUP	127	-1060.45	-427.996
KGUY	128	-399.88	-356.694
KGWO	129	640.075	-695.287
KHBG	130	737.58	-936.506
KHBR	131	-186.121	-551.122
KHDO	132	-211.719	-1180.077
KHEZ	133	545.517	-911.954
KHGX	134	187.376	-1166.957
KHKA	135	642.067	-423.71
KHKS	136	636.926	-825.191
KHLC	137	-242.098	-64.417
KHNB	138	870.668	-145.447
KHOB	139	-580.048	-790.648
KHOP	140	841.754	-324.602
KHOT	141	356.115	-603.71
KHOU	142	167.118	-1147.403
KHRL	143	-67.728	-1533.473

Table B-2. CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KHRO	144	343.012	-405.722
KHSB	145	737.259	-207.858
KHUM	146	616.723	-1136.814
KHUT	147	-75.456	-213.411
KHYI	148	-84.429	-1120.581
KHYS	149	-195.165	-124.724
KIAH	150	159.982	-1112.067
KICT	151	-36.491	-259.771
KIER	152	369.594	-908.657
KILE	153	-65.316	-988.473
KINK	154	-586.978	-890.95
KITR	155	-451.837	-69.8
KIXD	156	180.857	-126.914
KJAN	157	650.08	-826.487
KJBR	158	569.655	-440.988
KJCT	159	-264.805	-1049.863
KJEF	160	417.469	-143.696
KJLN	161	220.368	-310.284
KJSV	162	198.556	-502.06
KJWG	163	-127.44	-456.946
KLAA	164	-494.483	-198.304
KLAW	165	-129.378	-600.254
KLBB	166	-445.079	-691.2
KLBL	167	-350.15	-318.583
KLBX	168	150.63	-1207.65
KLCH	169	366.039	-1089.113
KLFK	170	214.642	-969.288
KLFT	171	483.139	-1074.12
KLHX	172	-567.01	-195.279
KLIC	173	-573.7	-69.147
KLIT	174	434.161	-571.401
KLLQ	175	485.203	-691.199
KLRD	176	-246.569	-1383.486
KLRU	177	-917.261	-803.759
KLSX	178	544.697	-124.925
KLVJ	179	172.567	-1160.745
KLVS	180	-731.441	-447.785
KLWC	181	153.636	-108.143
KLWV	182	809.107	-95.154
KMAF	183	-489.696	-878.105
KMCB	184	622.67	-955.341
KMCI	185	195.298	-73.101
KMDH	186	676.591	-216.245
KMEI	187	774.908	-814.191
KMEM	188	634.534	-523.229
KMFE	189	-125.361	-1538.535
KMHK	190	28.579	-93.934
KMKC	191	205.861	-94.951

Table B-2. CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KMKL	192	727.077	-454.381
KMKO	193	146.966	-478.029
KMLC	194	110.644	-565.417
KMLU	195	466.016	-816.792
KMOB	196	839.42	-992.943
KMRF	197	-676.239	-1042.652
KMSL	198	853.332	-536.843
KMSY	199	653.767	-1087.37
KMTJ	200	-939.546	-109.53
KMVN	201	704.695	-154.57
KMWA	202	698.685	-218.021
KMWL	203	-99.247	-798.862
KMWT	204	312.521	-597.597
KNEW	205	674.286	-1080.207
KNFW	206	-40.525	-801.069
KNGP	207	-28.264	-1368
KNQA	208	643.986	-489.146
KNQI	209	-81.68	-1390.219
KOCH	210	216.534	-930.592
KODO	211	-509.4	-880.305
KOJC	212	180.815	-125.068
KOKC	213	-54.186	-508.715
KOKM	214	94.479	-478.439
KOLV	215	654.146	-529.476
KOLY	216	759.691	-104.636
KOUN	217	-41.707	-526.861
KOWB	218	858.23	-202.317
KP28	219	-139.317	-297.355
KP92	220	557.13	-1172.603
KPAH	221	725.844	-291.476
KPBF	222	464.795	-631.204
KPIB	223	728.391	-915.201
KPIL	224	-33.55	-1540.831
KPNC	225	-9.037	-360.887
KPOF	226	591.592	-335.455
KPPF	227	130.459	-293.82
KPQL	228	814.856	-1019.221
KPRX	229	143.317	-703.629
KPSX	230	73.863	-1251.5
KPTN	231	551.151	-1123.941
KPUB	232	-651.703	-162.851
KPVJ	233	-20.054	-585.348
KPWA	234	-57.09	-493.927
KPWG	235	-30.433	-944.406
KRBD	236	12.481	-810.433
KRKP	237	-4.965	-1324.879
KRKR	238	216.017	-548.175
KROG	239	258.441	-397.719

Table B-2. CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KROW	240	-698.85	-712.895
KRQE	241	-1083.18	-409.162
KRSL	242	-156.389	-123.748
KRSN	243	413.677	-819.685
KRTN	244	-664.239	-331.996
KRUE	245	352.817	-517.944
KRVS	246	90.474	-437.23
KSAF	247	-816.558	-444.045
KSAR	248	634.139	-179.076
KSAT	249	-142.994	-1160.901
KSET	250	564.392	-97.842
KSGF	251	318.465	-299.61
KSGR	252	130.817	-1151.128
KSGT	253	495.691	-582.749
KSHV	254	298.831	-829.307
KSJT	255	-333.267	-950.677
KSKX	256	-770.438	-355.856
KSLG	257	224.802	-417.183
KSLN	258	-56.011	-132.485
KSLO	259	692.8	-118.63
KSNL	260	5.421	-513.325
KSPD	261	-493.802	-285.159
KSPS	262	-136.546	-666.72
KSRC	263	475.987	-516.167
KSRR	264	-789.624	-686.256
KSSF	265	-144.978	-1183.291
KSTL	266	570.065	-117.452
KSUS	267	549.336	-130.02
KSVC	268	-1043.578	-751.807
KSWO	269	-7.445	-423.979
KSZL	270	297.567	-136.247
KTAD	271	-644.899	-276.219
KTBN	272	423.924	-237.479
KTCC	273	-597.363	-511.501
KTCL	274	870.684	-704.299
KTCS	275	-952.322	-695.439
KTEX	276	-948.259	-169.74
KTIK	277	-34.608	-506.971
KTKI	278	38.139	-755.127
KTOP	279	117.322	-102.315
KTPL	280	-39.799	-981.183
KTQH	281	179.315	-448.216
KTRL	282	68.48	-806.796
KTUL	283	98.267	-419.701
KTUP	284	753.906	-600.367
KTVR	285	560.687	-829.118
KTXK	286	278.022	-720.622
KUNO	287	450.268	-332.422

Table B-2. CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KUTS	288	136.314	-1024.869
KVBT	289	247.807	-399.9
KVCT	290	8.192	-1238.695
KVIH	291	454.952	-193.303
KWLD	292	0	-320.695
KWWR	293	-225.565	-391.327
KXNA	294	240.016	-407.886
MMAN	295	-329.872	-1569.4
MMCL	296	-1072.535	-1632.775
MMMA	297	-54.487	-1586.451
MMMY	298	-316.613	-1579.702
MMNL	299	-257.222	-1394.843
MMPG	300	-346.402	-1248.84
MMRX	301	-125.617	-1557.41
KBLV	302	617.659	-136.018
KELD	303	389.07	-742.171
KF39	304	30.792	-697.387
KIAB	305	-23.366	-263.504
KSKF	306	-154.653	-1177.521
KTYR	307	150.418	-844.347
KWDG	308	-71.289	-399.691
KEAX	309	235.703	-128.032
KMEG	310	651.863	-512.89
KNBG	311	677.608	-1102.405
KLZK	312	431.199	-560.297
MMCS	313	-893.759	-880.938
KE33	314	-846.39	-298.154
KBIX	315	778.283	-1028.545
KLRF	316	440.656	-550.693
KFCS	317	-669.55	-116.96
KEND	318	-81.725	-403.278
KPOE	319	364.89	-984.772
KDYS	320	-267.671	-834.062
KHMN	321	-848.745	-749.371
KRND	322	-125.115	-1161.171
MMCU	323	-882.35	-1211.961
KBYH	324	631.187	-421.631
KFSI	325	-127.711	-591.042
KGVT	326	86.944	-767.36
KHLR	327	-68.45	-981.004
KNMM	328	789.841	-788.597
KLTS	329	-206.759	-589.446
KAFF	330	-671.158	-85.372
KCWF	331	371.999	-1077.296
KCBM	332	789.252	-665.842
KBAD	333	312.771	-825.1
KDLF	334	-369.535	-1173.036
MMTC	335	-660.346	-1590.033

Table B-2. CENRAP South Surface Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
MMMV	336	-444.934	-1449.379
KFRI	337	20.033	-105.018
K1H2	338	726.033	-68.974
KCPW	339	-858.907	-235.621
KMYP	340	-805.328	-126.737
KVTP	341	-715.975	-244.241
KHDC	342	632.988	-1028.708
KMNH	343	-652.817	-58.825
K3T5	344	4.852	-1119.865
KLXT	345	226.086	-111.723
KFWS	346	-28.156	-830.79
KJAS	347	284.559	-1005.649
KLIX	348	691.695	-1044.752
KSWW	349	-325.719	-827.955
KERV	350	-201.944	-1109.346
KBWD	351	-184.672	-906.806

Table B-3. CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K1H2	3	726.033	-68.974
K3T5	4	4.852	-1119.865
K4BL	5	-1088.794	-188.74
K4CR	6	-796.753	-614.946
K4MY	7	-820.552	-514.181
K4SL	8	-902.016	-397.882
K6R6	9	-504.682	-1089.929
KAAO	10	-19.239	-248.771
KABI	11	-252.073	-836.385
KABQ	12	-870.967	-501.552
KACT	13	-20.572	-929.193
KADH	14	30.04	-574.23
KADM	15	-1.531	-630.847
KADS	16	15.55	-778.91
KAEG	17	-886.431	-489.863
KAEX	18	424.008	-951.083
KAFW	19	-29.67	-778.139
KAIZ	20	387.096	-200.609
KALI	21	-102.174	-1362.836
KALM	22	-839.633	-752.147
KALN	23	597.6	-100.613
KALS	24	-777.382	-244.023
KAMA	25	-425.225	-516.367
KAQR	26	77.8	-619.389
KARA	27	495.794	-1092.463
KARG	28	543.544	-409.481
KASD	29	691.97	-1044.068
KASG	30	257.655	-419.895
KATS	31	-699.341	-756.355
KATT	32	-67.189	-1077.024
KAUS	33	-64.44	-1085.31
KAVK	34	-148.023	-355.847
KBAZ	35	-102.133	-1140.919
KBFM	36	857.496	-996.792
KBGD	37	-395.603	-466.083
KBLV	38	617.659	-136.018
KBMG	39	888.591	-45.013
KBMQ	40	-118.107	-1027.37
KBNA	41	920.716	-377.2
KBPK	42	404.476	-391.372
KBPT	43	289.282	-1110.638
KBRO	44	-44.198	-1571.387
KBTR	45	562.77	-1032.028
KBVE	46	741.254	-1153.502
KBVO	47	88.664	-358.933

Table B-3. CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KBVX	48	480.71	-457.819
KBWD	49	-184.672	-906.806
KCAO	50	-547.124	-374.102
KCDS	51	-300.324	-610.634
KCEZ	52	-1020.893	-233.136
KCFV	53	126.511	-320.682
KCGI	54	652.519	-279.306
KCHK	55	-87.955	-541.668
KCKV	56	850.158	-329.28
KCLL	57	60.926	-1044.347
KCNK	58	-55.418	-49.561
KCNM	59	-681.361	-822.067
KCNU	60	132.781	-256.9
KCNY	61	-1095.593	-59.385
KCOS	62	-663.999	-102.631
KCOT	63	-219.079	-1280.593
KCOU	64	411.894	-119.997
KCPS	65	591.654	-136.172
KCPW	66	-858.907	-235.621
KCQB	67	16.186	-473.43
KCQC	68	-775.182	-516.728
KCRP	69	-49.841	-1360.392
KCRS	70	56.76	-882.852
KCSM	71	-198.798	-512.028
KCVN	72	-556.268	-599.276
KCVS	73	-577.834	-601.516
KCXO	74	153.025	-1068.554
KDCU	75	915.854	-541.281
KDDC	76	-259.327	-242.715
KDEQ	77	238.943	-655.661
KDFW	78	-3.109	-786.339
KDHT	79	-496.517	-424.942
KDMN	80	-1006.923	-798.125
KDMO	81	336.438	-136.522
KDRO	82	-945.713	-259.162
KDRT	83	-382.557	-1172.484
KDTN	84	304.839	-822.047
KDTO	85	-18.599	-752.969
KDUA	86	56.176	-670.61
KDUC	87	-87.786	-611.524
KDWH	88	140.407	-1100.838
KDYR	89	679.855	-412.145
KEFD	90	178.542	-1150.911
KEHA	91	-431.288	-320.167
KEHR	92	812.8	-199.338
KELD	93	389.07	-742.171
KELP	94	-888.697	-862.785
KEMP	95	69.39	-183.984

Table B-3. CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KENL	96	683.539	-134.985
KERV	97	-201.944	-1109.346
KESF	98	447.345	-943.674
KEVV	99	822.902	-172.718
KEWK	100	-24.383	-215.58
KF39	101	30.792	-697.387
KFAM	102	573.877	-225.83
KFDR	103	-181.762	-623.071
KFLP	104	404.266	-399.14
KFMN	105	-993.475	-297.941
KFOA	106	735.051	-91.448
KFOE	107	114.644	-115.26
KFSM	108	237.996	-512.835
KFST	109	-566.391	-988.873
KFTW	110	-32.713	-795.542
KFWC	111	743.489	-143.961
KFWS	112	-28.156	-830.79
KFYV	113	253.764	-438.483
KGAG	114	-246.79	-405.469
KGBD	115	-162.152	-180.775
KGCK	116	-324.1	-221.895
KGCM	117	135.617	-409.198
KGDP	118	-737.521	-873.407
KGGG	119	214.599	-841.127
KGKY	120	-8.972	-812.595
KGLD	121	-401.583	-59.64
KGLE	122	-18.489	-702.977
KGLH	123	557.167	-701.877
KGLS	124	208.675	-1189.492
KGMJ	125	200.75	-372.417
KGNT	126	-985.121	-475.597
KGOK	127	-37.305	-458.997
KGPM	128	-4.681	-808.583
KGPT	129	764.04	-1031.678
KGRK	130	-79.671	-990.206
KGTR	131	779.037	-689.11
KGTU	132	-65.338	-1033.51
KGUC	133	-855.846	-113.585
KGUP	134	-1060.45	-427.996
KGUY	135	-399.88	-356.694
KGWO	136	640.075	-695.287
KHBG	137	737.58	-936.506
KHBR	138	-186.121	-551.122
KHDC	139	632.988	-1028.708
KHDO	140	-211.719	-1180.077
KHEZ	141	545.517	-911.954
KHKA	142	642.067	-423.71
KHKS	143	636.926	-825.191

Table B-3. CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KHLC	144	-242.098	-64.417
KHNB	145	870.668	-145.447
KHOB	146	-580.048	-790.648
KHOP	147	841.754	-324.602
KHOT	148	356.115	-603.71
KHOU	149	167.118	-1147.403
KHRL	150	-67.728	-1533.473
KHRO	151	343.012	-405.722
KHSB	152	737.259	-207.858
KHUM	153	616.723	-1136.814
KHUT	154	-75.456	-213.411
KHYI	155	-84.429	-1120.581
KHYS	156	-195.165	-124.724
KIAB	157	-23.366	-263.504
KIAH	158	159.982	-1112.067
KICT	159	-36.491	-259.771
KIER	160	369.594	-908.657
KILE	161	-65.316	-988.473
KINK	162	-586.978	-890.95
KITR	163	-451.837	-69.8
KIXD	164	180.857	-126.914
KJAN	165	650.08	-826.487
KJAS	166	284.559	-1005.649
KJBR	167	569.655	-440.988
KJCT	168	-264.805	-1049.863
KJEF	169	417.469	-143.696
KJLN	170	220.368	-310.284
KJSV	171	198.556	-502.06
KJWG	172	-127.44	-456.946
KLAA	173	-494.483	-198.304
KLAW	174	-129.378	-600.254
KLBB	175	-445.079	-691.2
KLBL	176	-350.15	-318.583
KLBX	177	150.63	-1207.65
KLCH	178	366.039	-1089.113
KLFK	179	214.642	-969.288
KLFT	180	483.139	-1074.12
KLHX	181	-567.01	-195.279
KLIC	182	-573.7	-69.147
KLIT	183	434.161	-571.401
KLIX	184	691.695	-1044.752
KLLQ	185	485.203	-691.199
KLRD	186	-246.569	-1383.486
KLRU	187	-917.261	-803.759
KLVJ	188	172.567	-1160.745
KLVS	189	-731.441	-447.785
KLWC	190	153.636	-108.143
KLWV	191	809.107	-95.154

Table B-3. CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KLXT	192	226.086	-111.723
KLZK	193	431.199	-560.297
KMAF	194	-489.696	-878.105
KMCB	195	622.67	-955.341
KMCI	196	195.298	-73.101
KMDH	197	676.591	-216.245
KMEG	198	651.863	-512.89
KMEI	199	774.908	-814.191
KMEM	200	634.534	-523.229
KMFE	201	-125.361	-1538.535
KMHK	202	28.579	-93.934
KMKC	203	205.861	-94.951
KMKL	204	727.077	-454.381
KMKO	205	146.966	-478.029
KMLC	206	110.644	-565.417
KMLU	207	466.016	-816.792
KMNH	208	-652.817	-58.825
KMOB	209	839.42	-992.943
KMRF	210	-676.239	-1042.652
KMSL	211	853.332	-536.843
KMSY	212	653.767	-1087.37
KMTJ	213	-939.546	-109.53
KMVN	214	704.695	-154.57
KMWA	215	698.685	-218.021
KMWL	216	-99.247	-798.862
KMWT	217	312.521	-597.597
KMYP	218	-805.328	-126.737
KNEW	219	674.286	-1080.207
KNFW	220	-40.525	-801.069
KNGP	221	-28.264	-1368
KNQI	222	-81.68	-1390.219
KOCH	223	216.534	-930.592
KODO	224	-509.4	-880.305
KOJC	225	180.815	-125.068
KOKC	226	-54.186	-508.715
KOKM	227	94.479	-478.439
KOLV	228	654.146	-529.476
KOLY	229	759.691	-104.636
KOUN	230	-41.707	-526.861
KOWB	231	858.23	-202.317
KP28	232	-139.317	-297.355
KP92	233	557.13	-1172.603
KPAH	234	725.844	-291.476
KPBF	235	464.795	-631.204
KPIB	236	728.391	-915.201
KPIL	237	-33.55	-1540.831
KPNC	238	-9.037	-360.887
KPOF	239	591.592	-335.455

Table B-3. CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KPPF	240	130.459	-293.82
KPQL	241	814.856	-1019.221
KPRX	242	143.317	-703.629
KPSX	243	73.863	-1251.5
KPTN	244	551.151	-1123.941
KPUB	245	-651.703	-162.851
KPVJ	246	-20.054	-585.348
KPWA	247	-57.09	-493.927
KPWG	248	-30.433	-944.406
KRBD	249	12.481	-810.433
KRKP	250	-4.965	-1324.879
KRKR	251	216.017	-548.175
KROG	252	258.441	-397.719
KROW	253	-698.85	-712.895
KRQE	254	-1083.18	-409.162
KRSL	255	-156.389	-123.748
KRTN	256	-664.239	-331.996
KRUE	257	352.817	-517.944
KRVS	258	90.474	-437.23
KSAF	259	-816.558	-444.045
KSAR	260	634.139	-179.076
KSAT	261	-142.994	-1160.901
KSET	262	564.392	-97.842
KSGF	263	318.465	-299.61
KSGR	264	130.817	-1151.128
KSGT	265	495.691	-582.749
KSHV	266	298.831	-829.307
KSJT	267	-333.267	-950.677
KSKF	268	-154.653	-1177.521
KSKX	269	-770.438	-355.856
KSLG	270	224.802	-417.183
KSLN	271	-56.011	-132.485
KSLO	272	692.8	-118.63
KSNL	273	5.421	-513.325
KSPD	274	-493.802	-285.159
KSPS	275	-136.546	-666.72
KSRC	276	475.987	-516.167
KSRR	277	-789.624	-686.256
KSSF	278	-144.978	-1183.291
KSTL	279	570.065	-117.452
KSUS	280	549.336	-130.02
KSVC	281	-1043.578	-751.807
KSWO	282	-7.445	-423.979
KSWW	283	-325.719	-827.955
KTAD	284	-644.899	-276.219
KTBN	285	423.924	-237.479
KTCC	286	-597.363	-511.501
KTCL	287	870.684	-704.299

Table B-3. CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KTCS	288	-952.322	-695.439
KTEX	289	-948.259	-169.74
KTIK	290	-34.608	-506.971
KTKI	291	38.139	-755.127
KTOP	292	117.322	-102.315
KTPL	293	-39.799	-981.183
KTQH	294	179.315	-448.216
KTRL	295	68.48	-806.796
KTUL	296	98.267	-419.701
KTUP	297	753.906	-600.367
KTVR	298	560.687	-829.118
KTXK	299	278.022	-720.622
KTYR	300	150.418	-844.347
KUNO	301	450.268	-332.422
KUTS	302	136.314	-1024.869
KVBT	303	247.807	-399.9
KVCT	304	8.192	-1238.695
KVIH	305	454.952	-193.303
KVTP	306	-715.975	-244.241
KWDG	307	-71.289	-399.691
KWLD	308	0	-320.695
KWWR	309	-225.565	-391.327
KXNA	310	240.016	-407.886
MMRX	311	-125.617	-1557.41
KDAL	312	14.014	-791.889
KNQA	313	643.986	-489.146
MMCL	314	-1072.535	-1632.775
MMMA	315	-54.487	-1586.451
KCWF	316	371.999	-1077.296
KEAX	317	235.703	-128.032
KFWD	318	-27.846	-793.612
MMMY	319	-316.613	-1579.702
KSZL	320	297.567	-136.247
MMNL	321	-257.222	-1394.843
MMPG	322	-346.402	-1248.84
MMCS	323	-893.759	-880.938
KE33	324	-846.39	-298.154
MMAN	325	-329.872	-1569.4
MMTC	326	-660.346	-1590.033
KEND	327	-81.725	-403.278
KLRF	328	440.656	-550.693
KHMN	329	-848.745	-749.371
KAFF	330	-671.158	-85.372
KBIX	331	778.283	-1028.545
KFCS	332	-669.55	-116.96
KBAD	333	312.771	-825.1
KBYH	334	631.187	-421.631
KDYS	335	-267.671	-834.062

Table B-3. CENRAP South Surface Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFSI	336	-127.711	-591.042
KHLR	337	-68.45	-981.004
KGVT	338	86.944	-767.36
KNMM	339	789.841	-788.597
KLTS	340	-206.759	-589.446
KRND	341	-125.115	-1161.171
MMCU	342	-882.35	-1211.961
KNBG	343	677.608	-1102.405
KCBM	344	789.252	-665.842
KPOE	345	364.89	-984.772
KDLF	346	-369.535	-1173.036
KRSN	347	413.677	-819.685
KLSX	348	544.697	-124.925
MMMV	349	-444.934	-1449.379
MMIO	350	-715.54	-1595.056
KSEP	351	-111.464	-861.645
K4T6	352	8.451	-835.284
K7F6	353	179.475	-707.745
KAWM	354	612.739	-515.624
KBKS	355	-112.415	-1422.608
KBPG	356	-425.646	-852.529
KBYY	357	111.937	-1224.526
KOSA	358	189.947	-761.973
KPYX	359	-333.955	-390.158
KT82	360	-184.545	-1081
KPVW	361	-432.871	-634.402
K25R	362	-114.5	-1509.609
K5T5	363	-9.437	-877.587
KE38	364	-643.74	-1043.615
KF05	365	-209.141	-635.991
KGYI	366	30.479	-695.167
KHHF	367	-304.913	-447.807
KHQZ	368	43.967	-802.91
KJSO	369	168.422	-899.337
KJWY	370	8.451	-835.284
KLBR	371	179.475	-707.745
KLUD	372	-53.902	-747.262
KSNK	373	-369.685	-801.662
KT53	374	-68.769	-1358.77
KRPH	375	-145.239	-761.747

Table B-4. CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K4BL	3	-1088.794	-188.74
K4CR	4	-796.753	-614.946
K4MY	5	-820.552	-514.181
K6R6	6	-504.682	-1089.929
KAAO	7	-19.239	-248.771
KABI	8	-252.073	-836.385
KABQ	9	-870.967	-501.552
KACT	10	-20.572	-929.193
KADH	11	30.04	-574.23
KADS	12	15.55	-778.91
KAEG	13	-886.431	-489.863
KAEX	14	424.008	-951.083
KAFW	15	-29.84	-864.178
KAIZ	16	387.096	-200.609
KALI	17	-103.042	-1363.706
KALM	18	-839.633	-752.147
KALN	19	597.6	-100.613
KALS	20	-777.382	-244.023
KAMA	21	-425.225	-516.367
KARA	22	495.794	-1092.463
KARG	23	543.544	-409.481
KASD	24	691.97	-1044.068
KASG	25	257.655	-419.895
KATS	26	-699.341	-756.355
KATT	27	-67.189	-1077.024
KAUS	28	-64.44	-1085.31
KBAZ	29	-102.133	-1140.919
KBFM	30	857.496	-996.792
KBGD	31	-395.603	-466.083
KBLV	32	617.659	-136.018
KBMG	33	888.591	-45.013
KBMQ	34	-118.107	-1027.37
KBNA	35	920.716	-377.2
KBPK	36	404.476	-391.372
KBPT	37	289.282	-1110.638
KBRO	38	-44.198	-1571.387
KBTR	39	562.77	-1032.028
KBVE	40	741.254	-1153.502
KBVO	41	88.664	-358.933
KBVX	42	480.71	-457.819
KCAO	43	-547.124	-374.102
KCDS	44	-300.324	-610.634
KCEZ	45	-1020.893	-233.136
KCFV	46	126.511	-320.682
KCGI	47	652.519	-279.306

Table B-4. CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KCLL	48	60.926	-1044.347
KCNK	49	-55.418	-49.561
KCNM	50	-682.759	-822.078
KCNU	51	132.781	-256.9
KCNY	52	-1095.593	-59.385
KCOS	53	-663.999	-102.631
KCOT	54	-219.067	-1280.964
KCOU	55	411.894	-119.997
KCPS	56	591.654	-136.172
KCQC	57	-775.182	-516.728
KCRP	58	-49.841	-1360.392
KCRS	59	56.76	-882.852
KCSM	60	-198.798	-512.028
KCVN	61	-556.268	-599.276
KCVS	62	-577.834	-601.516
KCXO	63	153.025	-1068.554
KDAL	64	14.014	-791.889
KDCU	65	915.854	-541.281
KDDC	66	-259.327	-242.715
KDFW	67	-3.109	-786.339
KDHT	68	-496.517	-424.942
KDLF	69	-369.535	-1173.036
KDMN	70	-1006.923	-798.125
KDMO	71	336.438	-136.522
KDRO	72	-945.713	-259.162
KDRT	73	-382.557	-1172.484
KDTN	74	304.839	-822.047
KDTO	75	-18.599	-752.969
KDWH	76	140.407	-1100.838
KDYR	77	679.855	-412.145
KEAX	78	235.703	-128.032
KEFD	79	178.542	-1150.911
KEHA	80	-431.288	-320.167
KEHR	81	812.8	-199.338
KELP	82	-888.697	-862.785
KEMP	83	69.39	-183.984
KEND	84	-81.725	-403.278
KEVV	85	822.902	-172.718
KEWK	86	-24.383	-215.58
KF39	87	30.792	-697.387
KFAM	88	573.877	-225.83
KFDR	89	-181.762	-623.071
KFLP	90	404.266	-399.14
KFMN	91	-993.475	-297.941
KFOE	92	114.644	-115.26
KFSM	93	237.996	-512.835
KFST	94	-566.391	-988.873
KFTW	95	-32.713	-795.542

Table B-4. CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFWD	96	-27.846	-793.612
KFYV	97	253.764	-438.483
KGAG	98	-246.79	-405.469
KGBD	99	-162.152	-180.775
KGCK	100	-324.1	-221.895
KGDP	101	-737.521	-873.407
KGGG	102	214.599	-841.127
KGKY	103	-8.972	-812.595
KGLD	104	-401.583	-59.64
KGLH	105	557.042	-703.065
KGLS	106	208.675	-1189.492
KGNT	107	-985.121	-475.597
KGOK	108	-37.305	-458.997
KGPM	109	-4.681	-808.583
KGPT	110	764.04	-1031.678
KGTR	111	779.037	-689.11
KGTU	112	-65.338	-1033.51
KGUC	113	-855.846	-113.585
KGUP	114	-1060.45	-427.996
KGUY	115	-399.88	-356.694
KGWO	116	640.075	-695.287
KHBG	117	737.58	-936.506
KHBR	118	-186.121	-551.122
KHDO	119	-211.719	-1180.077
KHEZ	120	545.517	-911.954
KHGX	121	187.376	-1166.957
KHKA	122	642.067	-423.71
KHKS	123	636.926	-825.191
KHLC	124	-242.098	-64.417
KHNB	125	870.668	-145.447
KHOP	126	841.754	-324.602
KHOT	127	356.463	-602.864
KHOU	128	167.118	-1147.403
KHRL	129	-67.728	-1533.473
KHRO	130	343.012	-405.722
KHUM	131	616.723	-1136.814
KHUT	132	-75.456	-213.411
KHYI	133	-84.429	-1120.581
KHYS	134	-195.165	-124.724
KIAB	135	-23.366	-263.504
KIAH	136	159.982	-1112.067
KICT	137	-36.491	-259.771
KIER	138	369.594	-908.657
KILE	139	-65.316	-988.473
KINK	140	-586.879	-890.621
KITR	141	-451.837	-69.8
KIXD	142	180.857	-126.914
KJAN	143	650.08	-826.487

Table B-4. CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KJBR	144	569.655	-440.988
KJCT	145	-264.805	-1049.863
KJEF	146	417.469	-143.696
KJLN	147	220.368	-310.284
KLAA	148	-494.483	-198.304
KLAW	149	-129.378	-600.254
KLBB	150	-445.079	-691.2
KLBL	151	-350.15	-318.583
KLBX	152	150.63	-1207.65
KLCH	153	366.039	-1089.113
KLFK	154	214.642	-969.288
KLFT	155	483.139	-1074.12
KLHX	156	-567.01	-195.279
KLIC	157	-573.7	-69.147
KLIT	158	434.161	-571.401
KLIX	159	691.695	-1044.752
KLLQ	160	485.203	-691.199
KLRD	161	-246.569	-1383.486
KLRF	162	440.656	-550.693
KLRU	163	-917.261	-803.759
KLSX	164	544.697	-124.925
KLVJ	165	172.567	-1160.745
KLVS	166	-731.441	-447.785
KLWC	167	153.636	-108.143
KLWV	168	809.107	-95.154
KMAF	169	-489.696	-878.105
KMCB	170	622.67	-955.341
KMCI	171	195.298	-73.101
KMDH	172	676.591	-216.245
KMEG	173	651.863	-512.89
KMEI	174	774.908	-814.191
KMEM	175	634.534	-523.229
KMFE	176	-125.361	-1538.535
KMHK	177	28.579	-93.934
KMKC	178	205.861	-94.951
KMKL	179	727.077	-454.381
KMKO	180	146.966	-478.029
KMLC	181	110.644	-565.417
KMOB	182	839.42	-992.943
KMRF	183	-676.239	-1042.652
KMSL	184	853.332	-536.843
KMSY	185	653.767	-1087.37
KMTJ	186	-939.546	-109.53
KMVN	187	704.695	-154.57
KMWA	188	698.685	-218.021
KMWL	189	-99.741	-798.734
KNEW	190	674.286	-1080.207
KNGP	191	-28.264	-1368

Table B-4. CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KNQA	192	643.986	-489.146
KOCH	193	216.534	-930.592
KODO	194	-509.4	-880.305
KOJC	195	180.815	-125.068
KOKC	196	-54.186	-508.715
KOUN	197	-41.707	-526.861
KOWB	198	858.23	-202.317
KP28	199	-139.317	-297.355
KP92	200	557.13	-1172.603
KPAH	201	725.844	-291.476
KPBF	202	464.795	-631.204
KPIB	203	728.391	-915.201
KPIL	204	-33.55	-1540.831
KPNC	205	-8.868	-361.264
KPOF	206	591.592	-335.455
KPPF	207	130.459	-293.82
KPQL	208	814.856	-1019.221
KPRX	209	143.317	-703.629
KPSX	210	73.879	-1253.364
KPTN	211	551.151	-1123.941
KPUB	212	-651.703	-162.851
KPWA	213	-57.09	-493.927
KPWG	214	-30.433	-944.406
KRBD	215	12.481	-810.433
KRKP	216	-4.965	-1324.879
KRND	217	-125.115	-1161.171
KROG	218	258.441	-397.719
KROW	219	-698.85	-712.895
KRQE	220	-1083.18	-409.162
KRSL	221	-156.389	-123.748
KRSN	222	413.677	-819.685
KRTN	223	-664.239	-331.996
KRUE	224	352.817	-517.944
KRVS	225	90.474	-437.23
KSAF	226	-816.558	-444.045
KSAT	227	-142.994	-1160.901
KSET	228	564.392	-97.842
KSGF	229	318.465	-299.61
KSGR	230	131.473	-1151.365
KSGT	231	495.691	-582.749
KSHV	232	298.831	-829.307
KSJT	233	-333.267	-950.677
KSKX	234	-812.696	-797.619
KSLG	235	224.802	-417.183
KSLN	236	-56.011	-132.485
KSPD	237	-493.802	-285.159
KSPS	238	-136.546	-666.72
KSRC	239	475.987	-516.167

Table B-4. CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KSRR	240	-789.624	-686.256
KSSF	241	-144.978	-1183.291
KSTL	242	570.065	-117.452
KSUS	243	549.336	-130.02
KSVC	244	-1043.578	-751.807
KSWO	245	-7.445	-423.979
KSZL	246	297.567	-136.247
KTAD	247	-645.048	-278.061
KTBN	248	423.924	-237.479
KTCC	249	-597.363	-511.501
KTCL	250	870.684	-704.299
KTCS	251	-952.322	-695.439
KTIK	252	-34.608	-506.971
KTKI	253	38.139	-755.127
KTOP	254	117.322	-102.315
KTPL	255	-39.799	-981.183
KTRL	256	68.48	-806.796
KTUL	257	98.267	-419.701
KTUP	258	753.906	-600.367
KTVR	259	560.687	-829.118
KTXK	260	278.022	-720.622
KTYR	261	150.418	-844.347
KUNO	262	450.268	-332.422
KUTS	263	136.314	-1024.869
KVBT	264	247.807	-399.9
KVCT	265	8.192	-1238.695
KVIH	266	454.952	-193.303
KWDG	267	-71.289	-399.691
KWLD	268	0	-320.695
KXNA	269	240.016	-407.886
MMCL	270	-1072.535	-1632.775
KCWF	271	371.999	-1077.296
KHOB	272	-580.048	-790.648
KPOE	273	364.89	-984.772
MMIO	274	-715.54	-1595.056
MMMY	275	-316.613	-1579.702
KGRK	276	-79.671	-990.206
KMLU	277	466.016	-816.792
KTEX	278	-948.259	-169.74
MMRX	279	-125.617	-1557.41
KESF	280	447.345	-943.674
KLZK	281	431.199	-560.297
KADM	282	-1.531	-630.847
MMNL	283	-257.222	-1394.843
KE33	284	-846.39	-298.154
MMAN	285	-329.872	-1569.4
MMCS	286	-893.759	-880.938
MMMA	287	-54.487	-1586.451

Table B-4. CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KMWT	288	312.521	-597.597
K4SL	289	-889.332	-391.854
KSKF	290	-154.653	-1177.521
KBIX	291	778.283	-1028.545
KCBM	292	789.252	-665.842
KDYS	293	-267.671	-834.062
KAFF	294	-671.158	-85.372
KLTS	295	-206.759	-589.446
KNBG	296	677.608	-1102.405
KBYH	297	631.187	-421.631
KHMN	298	-848.745	-749.371
KLAM	299	-831.464	-412.856
KNMM	300	789.841	-788.597
MMPG	301	-346.402	-1248.84
MMTC	302	-660.346	-1590.033
KFSI	303	-127.711	-591.042
KFCS	304	-669.55	-116.96
KNFW	305	-40.525	-801.069
KNQI	306	-81.68	-1390.219
KBAD	307	312.771	-825.1
KFRI	308	20.033	-105.018
KGVT	309	86.944	-767.36
KHLR	310	-68.45	-981.004
KELD	311	390.361	-742.112
MMCU	312	-882.35	-1211.961
MMMV	313	-444.934	-1449.379
KEPZ	314	-915.897	-851.724
KAVK	315	-148.023	-355.847
KGMJ	316	200.75	-372.417
KPVJ	317	-20.054	-585.348
KRKR	318	216.017	-548.175
KCKV	319	849.69	-329.329
KOLV	320	654.146	-529.476
KDEQ	321	239.058	-655.169
KSLO	322	692.8	-118.63
KWWR	323	-225.565	-391.327
KAQR	324	77.8	-619.389
KCHK	325	-87.955	-541.668
KCQB	326	16.186	-473.43
KDUA	327	56.176	-670.61
KDUC	328	-87.786	-611.524
KENL	329	683.539	-134.985
KFOA	330	735.051	-91.448
KFWC	331	743.489	-143.961
KGCM	332	135.617	-409.198
KGLE	333	-18.489	-702.977
KHSB	334	737.259	-207.858
KJSV	335	198.556	-502.06

Table B-4. CENRAP South Precipitation Stations - 2001

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KJWG	336	-127.44	-456.946
KOKM	337	94.479	-478.439
KOLY	338	759.691	-104.636
KSAR	339	634.139	-179.076
KSNL	340	5.421	-513.325
KTQH	341	179.315	-448.216
K1H2	342	726.033	-68.974
KCPW	343	-858.907	-235.621
KMYP	344	-805.328	-126.737
KVTP	345	-715.975	-244.241
KHDC	346	632.988	-1028.708
KMNH	347	-652.817	-58.825

Table B-5. CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K4BL	3	-1088.794	-188.74
K4CR	4	-796.753	-614.946
K4MY	5	-820.552	-514.181
K4SL	6	-902.016	-397.882
K6R6	7	-504.682	-1089.929
KAAO	8	-19.239	-248.771
KABI	9	-252.073	-836.385
KABQ	10	-870.967	-501.552
KACT	11	-20.572	-929.193
KADH	12	30.04	-574.23
KADM	13	-1.531	-630.847
KADS	14	15.55	-778.91
KAEG	15	-886.431	-489.863
KAEX	16	424.008	-951.083
KAFW	17	-29.67	-778.139
KAIZ	18	387.096	-200.609
KALI	19	-102.174	-1362.836
KALM	20	-839.633	-752.147
KALN	21	597.6	-100.613
KALS	22	-777.382	-244.023
KAMA	23	-425.225	-516.367
KAQR	24	77.8	-619.389
KARA	25	495.794	-1092.463
KARG	26	543.544	-409.481
KASD	27	691.97	-1044.068
KASG	28	257.655	-419.895
KATS	29	-699.341	-756.355
KATT	30	-67.189	-1077.024
KAUS	31	-64.44	-1085.31
KAVK	32	-148.023	-355.847
KBAZ	33	-102.133	-1140.919
KBFM	34	857.496	-996.792
KBGD	35	-395.603	-466.083
KBMG	36	888.591	-45.013
KBMQ	37	-118.107	-1027.37
KBNA	38	920.716	-377.2
KBPK	39	404.476	-391.372
KBPT	40	289.282	-1110.638
KBRO	41	-44.198	-1571.387
KBTR	42	562.77	-1032.028
KBVE	43	741.254	-1153.502
KBVO	44	88.664	-358.933
KBVX	45	480.71	-457.819
KCAO	46	-547.124	-374.102
KCDS	47	-300.324	-610.634

Table B-5. CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KCEZ	48	-1020.893	-233.136
KCFV	49	126.511	-320.682
KCGI	50	652.519	-279.306
KCHK	51	-87.955	-541.668
KCKV	52	850.158	-329.28
KCLL	53	60.926	-1044.347
KCNK	54	-55.418	-49.561
KCNM	55	-681.361	-822.067
KCNU	56	132.781	-256.9
KCNY	57	-1095.593	-59.385
KCOS	58	-663.999	-102.631
KCOT	59	-219.079	-1280.593
KCOU	60	411.894	-119.997
KCPS	61	591.654	-136.172
KCQB	62	16.186	-473.43
KCQC	63	-775.182	-516.728
KCRP	64	-49.841	-1360.392
KCRS	65	56.76	-882.852
KCSM	66	-198.798	-512.028
KCVN	67	-556.268	-599.276
KCVS	68	-577.834	-601.516
KCXO	69	153.025	-1068.554
KDAL	70	14.014	-791.889
KDCU	71	915.854	-541.281
KDDC	72	-259.327	-242.715
KDEQ	73	238.943	-655.661
KDFW	74	-3.109	-786.339
KDHT	75	-496.517	-424.942
KDMN	76	-1006.923	-798.125
KDMO	77	336.438	-136.522
KDRO	78	-945.713	-259.162
KDRT	79	-382.557	-1172.484
KDTN	80	304.839	-822.047
KDTO	81	-18.599	-752.969
KDUA	82	56.176	-670.61
KDUC	83	-87.786	-611.524
KDWH	84	140.407	-1100.838
KDYR	85	679.855	-412.145
KEFD	86	178.542	-1150.911
KEHA	87	-431.288	-320.167
KEHR	88	812.8	-199.338
KELP	89	-888.697	-862.785
KEMP	90	69.39	-183.984
KENL	91	683.539	-134.985
KESF	92	447.345	-943.674
KEVV	93	822.902	-172.718
KEWK	94	-24.383	-215.58
KFAM	95	573.877	-225.83

Table B-5. CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFDR	96	-181.762	-623.071
KFLP	97	404.266	-399.14
KFMN	98	-993.475	-297.941
KFOA	99	735.051	-91.448
KFOE	100	114.644	-115.26
KFSM	101	237.996	-512.835
KFST	102	-566.391	-988.873
KFTW	103	-32.713	-795.542
KFWC	104	743.489	-143.961
KFWD	105	-27.846	-793.612
KFYV	106	253.764	-438.483
KGAG	107	-246.79	-405.469
KGBD	108	-162.152	-180.775
KGCK	109	-324.1	-221.895
KGCM	110	135.617	-409.198
KGDP	111	-737.521	-873.407
KGGG	112	214.599	-841.127
KGKY	113	-8.972	-812.595
KGLD	114	-401.583	-59.64
KGLE	115	-18.489	-702.977
KGLH	116	557.167	-701.877
KGLS	117	208.675	-1189.492
KGMJ	118	200.75	-372.417
KGNT	119	-985.121	-475.597
KGOK	120	-37.305	-458.997
KGPM	121	-4.681	-808.583
KGPT	122	764.04	-1031.678
KGRK	123	-79.671	-990.206
KGTR	124	779.037	-689.11
KGTU	125	-65.338	-1033.51
KGUC	126	-855.846	-113.585
KGUP	127	-1060.45	-427.996
KGUY	128	-399.88	-356.694
KGWO	129	640.075	-695.287
KHBG	130	737.58	-936.506
KHBR	131	-186.121	-551.122
KHDO	132	-211.719	-1180.077
KHEZ	133	545.517	-911.954
KHGX	134	187.376	-1166.957
KHKA	135	642.067	-423.71
KHKS	136	636.926	-825.191
KHLC	137	-242.098	-64.417
KHNB	138	870.668	-145.447
KHOB	139	-580.048	-790.648
KHOP	140	841.754	-324.602
KHOT	141	356.115	-603.71
KHOU	142	167.118	-1147.403
KHRL	143	-67.728	-1533.473

Table B-5. CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KHRO	144	343.012	-405.722
KHSB	145	737.259	-207.858
KHUM	146	616.723	-1136.814
KHUT	147	-75.456	-213.411
KHYI	148	-84.429	-1120.581
KHYS	149	-195.165	-124.724
KIAH	150	159.982	-1112.067
KICT	151	-36.491	-259.771
KIER	152	369.594	-908.657
KILE	153	-65.316	-988.473
KINK	154	-586.978	-890.95
KITR	155	-451.837	-69.8
KIXD	156	180.857	-126.914
KJAN	157	650.08	-826.487
KJBR	158	569.655	-440.988
KJCT	159	-264.805	-1049.863
KJEF	160	417.469	-143.696
KJLN	161	220.368	-310.284
KJSV	162	198.556	-502.06
KJWG	163	-127.44	-456.946
KLAA	164	-494.483	-198.304
KLAW	165	-129.378	-600.254
KLBB	166	-445.079	-691.2
KLBL	167	-350.15	-318.583
KLBX	168	150.63	-1207.65
KLCH	169	366.039	-1089.113
KLFK	170	214.642	-969.288
KLFT	171	483.139	-1074.12
KLHX	172	-567.01	-195.279
KLIC	173	-573.7	-69.147
KLIT	174	434.161	-571.401
KLLQ	175	485.203	-691.199
KLRD	176	-246.569	-1383.486
KLRU	177	-917.261	-803.759
KLSX	178	544.697	-124.925
KLVJ	179	172.567	-1160.745
KLVS	180	-731.441	-447.785
KLWC	181	153.636	-108.143
KLWV	182	809.107	-95.154
KMAF	183	-489.696	-878.105
KMCB	184	622.67	-955.341
KMCI	185	195.298	-73.101
KMDH	186	676.591	-216.245
KMEI	187	774.908	-814.191
KMEM	188	634.534	-523.229
KMFE	189	-125.361	-1538.535
KMHK	190	28.579	-93.934
KMKC	191	205.861	-94.951

Table B-5. CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KMKL	192	727.077	-454.381
KMKO	193	146.966	-478.029
KMLC	194	110.644	-565.417
KMLU	195	466.016	-816.792
KMOB	196	839.42	-992.943
KMRF	197	-676.239	-1042.652
KMSL	198	853.332	-536.843
KMSY	199	653.767	-1087.37
KMTJ	200	-939.546	-109.53
KMVN	201	704.695	-154.57
KMWA	202	698.685	-218.021
KMWL	203	-99.247	-798.862
KMWT	204	312.521	-597.597
KNEW	205	674.286	-1080.207
KNFW	206	-40.525	-801.069
KNGP	207	-28.264	-1368
KNQA	208	643.986	-489.146
KNQI	209	-81.68	-1390.219
KOCH	210	216.534	-930.592
KODO	211	-509.4	-880.305
KOJC	212	180.815	-125.068
KOKC	213	-54.186	-508.715
KOKM	214	94.479	-478.439
KOLV	215	654.146	-529.476
KOLY	216	759.691	-104.636
KOUN	217	-41.707	-526.861
KOWB	218	858.23	-202.317
KP28	219	-139.317	-297.355
KP92	220	557.13	-1172.603
KPAH	221	725.844	-291.476
KPBF	222	464.795	-631.204
KPIB	223	728.391	-915.201
KPIL	224	-33.55	-1540.831
KPNC	225	-9.037	-360.887
KPOF	226	591.592	-335.455
KPPF	227	130.459	-293.82
KPQL	228	814.856	-1019.221
KPRX	229	143.317	-703.629
KPSX	230	73.863	-1251.5
KPTN	231	551.151	-1123.941
KPUB	232	-651.703	-162.851
KPVJ	233	-20.054	-585.348
KPWA	234	-57.09	-493.927
KPWG	235	-30.433	-944.406
KRBD	236	12.481	-810.433
KRKP	237	-4.965	-1324.879
KRKR	238	216.017	-548.175
KROG	239	258.441	-397.719

Table B-5. CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KROW	240	-698.85	-712.895
KRQE	241	-1083.18	-409.162
KRSL	242	-156.389	-123.748
KRSN	243	413.677	-819.685
KRTN	244	-664.239	-331.996
KRUE	245	352.817	-517.944
KRVS	246	90.474	-437.23
KSAF	247	-816.558	-444.045
KSAR	248	634.139	-179.076
KSAT	249	-142.994	-1160.901
KSET	250	564.392	-97.842
KSGF	251	318.465	-299.61
KSGR	252	130.817	-1151.128
KSGT	253	495.691	-582.749
KSHV	254	298.831	-829.307
KSJT	255	-333.267	-950.677
KSKX	256	-770.438	-355.856
KSLG	257	224.802	-417.183
KSLN	258	-56.011	-132.485
KSLO	259	692.8	-118.63
KSNL	260	5.421	-513.325
KSPD	261	-493.802	-285.159
KSPS	262	-136.546	-666.72
KSRC	263	475.987	-516.167
KSRR	264	-789.624	-686.256
KSSF	265	-144.978	-1183.291
KSTL	266	570.065	-117.452
KSUS	267	549.336	-130.02
KSVC	268	-1043.578	-751.807
KSWO	269	-7.445	-423.979
KSZL	270	297.567	-136.247
KTAD	271	-644.899	-276.219
KTBN	272	423.924	-237.479
KTCC	273	-597.363	-511.501
KTCL	274	870.684	-704.299
KTCS	275	-952.322	-695.439
KTEX	276	-948.259	-169.74
KTIK	277	-34.608	-506.971
KTKI	278	38.139	-755.127
KTOP	279	117.322	-102.315
KTPL	280	-39.799	-981.183
KTQH	281	179.315	-448.216
KTRL	282	68.48	-806.796
KTUL	283	98.267	-419.701
KTUP	284	753.906	-600.367
KTVR	285	560.687	-829.118
KTXK	286	278.022	-720.622
KUNO	287	450.268	-332.422

Table B-5. CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KUTS	288	136.314	-1024.869
KVBT	289	247.807	-399.9
KVCT	290	8.192	-1238.695
KVIH	291	454.952	-193.303
KWLD	292	0	-320.695
KWWR	293	-225.565	-391.327
KXNA	294	240.016	-407.886
MMAN	295	-329.872	-1569.4
MMCL	296	-1072.535	-1632.775
MMMA	297	-54.487	-1586.451
MMMY	298	-316.613	-1579.702
MMNL	299	-257.222	-1394.843
MMPG	300	-346.402	-1248.84
MMRX	301	-125.617	-1557.41
KBLV	302	617.659	-136.018
KELD	303	389.07	-742.171
KF39	304	30.792	-697.387
KIAB	305	-23.366	-263.504
KSKF	306	-154.653	-1177.521
KTYR	307	150.418	-844.347
KWDG	308	-71.289	-399.691
KEAX	309	235.703	-128.032
KMEG	310	651.863	-512.89
KNBG	311	677.608	-1102.405
KLZK	312	431.199	-560.297
MMCS	313	-893.759	-880.938
KE33	314	-846.39	-298.154
KBIX	315	778.283	-1028.545
KLRF	316	440.656	-550.693
KFCS	317	-669.55	-116.96
KEND	318	-81.725	-403.278
KPOE	319	364.89	-984.772
KDYS	320	-267.671	-834.062
KHMN	321	-848.745	-749.371
KRND	322	-125.115	-1161.171
MMCU	323	-882.35	-1211.961
KBYH	324	631.187	-421.631
KFSI	325	-127.711	-591.042
KGVT	326	86.944	-767.36
KHLR	327	-68.45	-981.004
KNMM	328	789.841	-788.597
KLTS	329	-206.759	-589.446
KAFF	330	-671.158	-85.372
KCWF	331	371.999	-1077.296
KCBM	332	789.252	-665.842
KBAD	333	312.771	-825.1
KDLF	334	-369.535	-1173.036
MMTC	335	-660.346	-1590.033

Table B-5. CENRAP South Precipitation Stations - 2002

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
MMMV	336	-444.934	-1449.379
KFRI	337	20.033	-105.018
K1H2	338	726.033	-68.974
KCPW	339	-858.907	-235.621
KMYP	340	-805.328	-126.737
KVTP	341	-715.975	-244.241
KHDC	342	632.988	-1028.708
KMNH	343	-652.817	-58.825
K3T5	344	4.852	-1119.865
KLXT	345	226.086	-111.723
KFWS	346	-28.156	-830.79
KJAS	347	284.559	-1005.649
KLIX	348	691.695	-1044.752
KSWW	349	-325.719	-827.955
KERV	350	-201.944	-1109.346
KBWD	351	-184.672	-906.806

Table B-6. CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
K11R	1	60.89	-1084.966
K1F0	2	-11.018	-645.265
K1H2	3	726.033	-68.974
K3T5	4	4.852	-1119.865
K4BL	5	-1088.794	-188.74
K4CR	6	-796.753	-614.946
K4MY	7	-820.552	-514.181
K4SL	8	-902.016	-397.882
K6R6	9	-504.682	-1089.929
KAAO	10	-19.239	-248.771
KABI	11	-252.073	-836.385
KABQ	12	-870.967	-501.552
KACT	13	-20.572	-929.193
KADH	14	30.04	-574.23
KADM	15	-1.531	-630.847
KADS	16	15.55	-778.91
KAEG	17	-886.431	-489.863
KAEX	18	424.008	-951.083
KAFW	19	-29.67	-778.139
KAIZ	20	387.096	-200.609
KALI	21	-102.174	-1362.836
KALM	22	-839.633	-752.147
KALN	23	597.6	-100.613
KALS	24	-777.382	-244.023
KAMA	25	-425.225	-516.367
KAQR	26	77.8	-619.389
KARA	27	495.794	-1092.463
KARG	28	543.544	-409.481
KASD	29	691.97	-1044.068
KASG	30	257.655	-419.895
KATS	31	-699.341	-756.355
KATT	32	-67.189	-1077.024
KAUS	33	-64.44	-1085.31
KAVK	34	-148.023	-355.847
KBAZ	35	-102.133	-1140.919
KBFM	36	857.496	-996.792
KBGD	37	-395.603	-466.083
KBLV	38	617.659	-136.018
KBMG	39	888.591	-45.013
KBMQ	40	-118.107	-1027.37
KBNA	41	920.716	-377.2
KBPK	42	404.476	-391.372
KBPT	43	289.282	-1110.638
KBRO	44	-44.198	-1571.387
KBTR	45	562.77	-1032.028
KBVE	46	741.254	-1153.502
KBVO	47	88.664	-358.933

Table B-6. CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KBVX	48	480.71	-457.819
KBWD	49	-184.672	-906.806
KCAO	50	-547.124	-374.102
KCDS	51	-300.324	-610.634
KCEZ	52	-1020.893	-233.136
KCFV	53	126.511	-320.682
KCGI	54	652.519	-279.306
KCHK	55	-87.955	-541.668
KCKV	56	850.158	-329.28
KCLL	57	60.926	-1044.347
KCNK	58	-55.418	-49.561
KCNM	59	-681.361	-822.067
KCNU	60	132.781	-256.9
KCNY	61	-1095.593	-59.385
KCOS	62	-663.999	-102.631
KCOT	63	-219.079	-1280.593
KCOU	64	411.894	-119.997
KCPS	65	591.654	-136.172
KCPW	66	-858.907	-235.621
KCQB	67	16.186	-473.43
KCQC	68	-775.182	-516.728
KCRP	69	-49.841	-1360.392
KCRS	70	56.76	-882.852
KCSM	71	-198.798	-512.028
KCVN	72	-556.268	-599.276
KCVS	73	-577.834	-601.516
KCXO	74	153.025	-1068.554
KDCU	75	915.854	-541.281
KDDC	76	-259.327	-242.715
KDEQ	77	238.943	-655.661
KDFW	78	-3.109	-786.339
KDHT	79	-496.517	-424.942
KDMN	80	-1006.923	-798.125
KDMO	81	336.438	-136.522
KDRO	82	-945.713	-259.162
KDRT	83	-382.557	-1172.484
KDTN	84	304.839	-822.047
KDTO	85	-18.599	-752.969
KDUA	86	56.176	-670.61
KDUC	87	-87.786	-611.524
KDWH	88	140.407	-1100.838
KDYR	89	679.855	-412.145
KEFD	90	178.542	-1150.911
KEHA	91	-431.288	-320.167
KEHR	92	812.8	-199.338
KELD	93	389.07	-742.171
KELP	94	-888.697	-862.785
KEMP	95	69.39	-183.984

Table B-6. CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KENL	96	683.539	-134.985
KERV	97	-201.944	-1109.346
KESF	98	447.345	-943.674
KEVV	99	822.902	-172.718
KEWK	100	-24.383	-215.58
KF39	101	30.792	-697.387
KFAM	102	573.877	-225.83
KFDR	103	-181.762	-623.071
KFLP	104	404.266	-399.14
KFMN	105	-993.475	-297.941
KFOA	106	735.051	-91.448
KFOE	107	114.644	-115.26
KFSM	108	237.996	-512.835
KFST	109	-566.391	-988.873
KFTW	110	-32.713	-795.542
KFWC	111	743.489	-143.961
KFWS	112	-28.156	-830.79
KFYV	113	253.764	-438.483
KGAG	114	-246.79	-405.469
KGBD	115	-162.152	-180.775
KGCK	116	-324.1	-221.895
KGCM	117	135.617	-409.198
KGDP	118	-737.521	-873.407
KGGG	119	214.599	-841.127
KGKY	120	-8.972	-812.595
KGLD	121	-401.583	-59.64
KGLE	122	-18.489	-702.977
KGLH	123	557.167	-701.877
KGLS	124	208.675	-1189.492
KGMJ	125	200.75	-372.417
KGNT	126	-985.121	-475.597
KGOK	127	-37.305	-458.997
KGPM	128	-4.681	-808.583
KGPT	129	764.04	-1031.678
KGRK	130	-79.671	-990.206
KGTR	131	779.037	-689.11
KGTU	132	-65.338	-1033.51
KGUC	133	-855.846	-113.585
KGUP	134	-1060.45	-427.996
KGUY	135	-399.88	-356.694
KGWO	136	640.075	-695.287
KHBG	137	737.58	-936.506
KHBR	138	-186.121	-551.122
KHDC	139	632.988	-1028.708
KHDO	140	-211.719	-1180.077
KHEZ	141	545.517	-911.954
KHKA	142	642.067	-423.71
KHKS	143	636.926	-825.191

Table B-6. CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KHLC	144	-242.098	-64.417
KHNB	145	870.668	-145.447
KHOB	146	-580.048	-790.648
KHOP	147	841.754	-324.602
KHOT	148	356.115	-603.71
KHOU	149	167.118	-1147.403
KHRL	150	-67.728	-1533.473
KHRO	151	343.012	-405.722
KHSB	152	737.259	-207.858
KHUM	153	616.723	-1136.814
KHUT	154	-75.456	-213.411
KHYI	155	-84.429	-1120.581
KHYS	156	-195.165	-124.724
KIAB	157	-23.366	-263.504
KIAH	158	159.982	-1112.067
KICT	159	-36.491	-259.771
KIER	160	369.594	-908.657
KILE	161	-65.316	-988.473
KINK	162	-586.978	-890.95
KITR	163	-451.837	-69.8
KIXD	164	180.857	-126.914
KJAN	165	650.08	-826.487
KJAS	166	284.559	-1005.649
KJBR	167	569.655	-440.988
KJCT	168	-264.805	-1049.863
KJEF	169	417.469	-143.696
KJLN	170	220.368	-310.284
KJSV	171	198.556	-502.06
KJWG	172	-127.44	-456.946
KLAA	173	-494.483	-198.304
KLAW	174	-129.378	-600.254
KLBB	175	-445.079	-691.2
KLBL	176	-350.15	-318.583
KLBX	177	150.63	-1207.65
KLCH	178	366.039	-1089.113
KLFK	179	214.642	-969.288
KLFT	180	483.139	-1074.12
KLHX	181	-567.01	-195.279
KLIC	182	-573.7	-69.147
KLIT	183	434.161	-571.401
KLIX	184	691.695	-1044.752
KLLQ	185	485.203	-691.199
KLRD	186	-246.569	-1383.486
KLRU	187	-917.261	-803.759
KLVJ	188	172.567	-1160.745
KLVS	189	-731.441	-447.785
KLWC	190	153.636	-108.143
KLWV	191	809.107	-95.154

Table B-6. CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KLXT	192	226.086	-111.723
KLZK	193	431.199	-560.297
KMAF	194	-489.696	-878.105
KMCB	195	622.67	-955.341
KMCI	196	195.298	-73.101
KMDH	197	676.591	-216.245
KMEG	198	651.863	-512.89
KMEI	199	774.908	-814.191
KMEM	200	634.534	-523.229
KMFE	201	-125.361	-1538.535
KMHK	202	28.579	-93.934
KMKC	203	205.861	-94.951
KMKL	204	727.077	-454.381
KMKO	205	146.966	-478.029
KMLC	206	110.644	-565.417
KMLU	207	466.016	-816.792
KMNH	208	-652.817	-58.825
KMOB	209	839.42	-992.943
KMRF	210	-676.239	-1042.652
KMSL	211	853.332	-536.843
KMSY	212	653.767	-1087.37
KMTJ	213	-939.546	-109.53
KMVN	214	704.695	-154.57
KMWA	215	698.685	-218.021
KMWL	216	-99.247	-798.862
KMWT	217	312.521	-597.597
KMYP	218	-805.328	-126.737
KNEW	219	674.286	-1080.207
KNFW	220	-40.525	-801.069
KNGP	221	-28.264	-1368
KNQI	222	-81.68	-1390.219
KOCH	223	216.534	-930.592
KODO	224	-509.4	-880.305
KOJC	225	180.815	-125.068
KOKC	226	-54.186	-508.715
KOKM	227	94.479	-478.439
KOLV	228	654.146	-529.476
KOLY	229	759.691	-104.636
KOUN	230	-41.707	-526.861
KOWB	231	858.23	-202.317
KP28	232	-139.317	-297.355
KP92	233	557.13	-1172.603
KPAH	234	725.844	-291.476
KPBF	235	464.795	-631.204
KPIB	236	728.391	-915.201
KPIL	237	-33.55	-1540.831
KPNC	238	-9.037	-360.887
KPOF	239	591.592	-335.455

Table B-6. CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KPPF	240	130.459	-293.82
KPQL	241	814.856	-1019.221
KPRX	242	143.317	-703.629
KPSX	243	73.863	-1251.5
KPTN	244	551.151	-1123.941
KPUB	245	-651.703	-162.851
KPVJ	246	-20.054	-585.348
KPWA	247	-57.09	-493.927
KPWG	248	-30.433	-944.406
KRBD	249	12.481	-810.433
KRKP	250	-4.965	-1324.879
KRKR	251	216.017	-548.175
KROG	252	258.441	-397.719
KROW	253	-698.85	-712.895
KRQE	254	-1083.18	-409.162
KRSL	255	-156.389	-123.748
KRTN	256	-664.239	-331.996
KRUE	257	352.817	-517.944
KRVS	258	90.474	-437.23
KSAF	259	-816.558	-444.045
KSAR	260	634.139	-179.076
KSAT	261	-142.994	-1160.901
KSET	262	564.392	-97.842
KSGF	263	318.465	-299.61
KSGR	264	130.817	-1151.128
KSGT	265	495.691	-582.749
KSHV	266	298.831	-829.307
KSJT	267	-333.267	-950.677
KSKF	268	-154.653	-1177.521
KSKX	269	-770.438	-355.856
KSLG	270	224.802	-417.183
KSLN	271	-56.011	-132.485
KSLO	272	692.8	-118.63
KSNL	273	5.421	-513.325
KSPD	274	-493.802	-285.159
KSPS	275	-136.546	-666.72
KSRC	276	475.987	-516.167
KSRR	277	-789.624	-686.256
KSSF	278	-144.978	-1183.291
KSTL	279	570.065	-117.452
KSUS	280	549.336	-130.02
KSVC	281	-1043.578	-751.807
KSWO	282	-7.445	-423.979
KSWW	283	-325.719	-827.955
KTAD	284	-644.899	-276.219
KTBN	285	423.924	-237.479
KTCC	286	-597.363	-511.501
KTCL	287	870.684	-704.299

Table B-6. CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KTCS	288	-952.322	-695.439
KTEX	289	-948.259	-169.74
KTIK	290	-34.608	-506.971
KTKI	291	38.139	-755.127
KTOP	292	117.322	-102.315
KTPL	293	-39.799	-981.183
KTQH	294	179.315	-448.216
KTRL	295	68.48	-806.796
KTUL	296	98.267	-419.701
KTUP	297	753.906	-600.367
KTVR	298	560.687	-829.118
KTXK	299	278.022	-720.622
KTYR	300	150.418	-844.347
KUNO	301	450.268	-332.422
KUTS	302	136.314	-1024.869
KVBT	303	247.807	-399.9
KVCT	304	8.192	-1238.695
KVIH	305	454.952	-193.303
KVTP	306	-715.975	-244.241
KWDG	307	-71.289	-399.691
KWLD	308	0	-320.695
KWWR	309	-225.565	-391.327
KXNA	310	240.016	-407.886
MMRX	311	-125.617	-1557.41
KDAL	312	14.014	-791.889
KNQA	313	643.986	-489.146
MMCL	314	-1072.535	-1632.775
MMMA	315	-54.487	-1586.451
KCWF	316	371.999	-1077.296
KEAX	317	235.703	-128.032
KFWD	318	-27.846	-793.612
MMMY	319	-316.613	-1579.702
KSZL	320	297.567	-136.247
MMNL	321	-257.222	-1394.843
MMPG	322	-346.402	-1248.84
MMCS	323	-893.759	-880.938
KE33	324	-846.39	-298.154
MMAN	325	-329.872	-1569.4
MMTC	326	-660.346	-1590.033
KEND	327	-81.725	-403.278
KLRF	328	440.656	-550.693
KHMN	329	-848.745	-749.371
KAFF	330	-671.158	-85.372
KBIX	331	778.283	-1028.545
KFCS	332	-669.55	-116.96
KBAD	333	312.771	-825.1
KBYH	334	631.187	-421.631
KDYS	335	-267.671	-834.062

Table B-6. CENRAP South Precipitation Stations - 2003

Initials	Station No.	LCP X-Coord (km)	LCP Y-Coord (km)
KFSI	336	-127.711	-591.042
KHLR	337	-68.45	-981.004
KGVT	338	86.944	-767.36
KNMM	339	789.841	-788.597
KLTS	340	-206.759	-589.446
KRND	341	-125.115	-1161.171
MMCU	342	-882.35	-1211.961
KNBG	343	677.608	-1102.405
KCBM	344	789.252	-665.842
KPOE	345	364.89	-984.772
KDLF	346	-369.535	-1173.036
KRSN	347	413.677	-819.685
KLSX	348	544.697	-124.925
MMMV	349	-444.934	-1449.379
MMIO	350	-715.54	-1595.056
KSEP	351	-111.464	-861.645
K4T6	352	8.451	-835.284
K7F6	353	179.475	-707.745
KAWM	354	612.739	-515.624
KBKS	355	-112.415	-1422.608
KBPG	356	-425.646	-852.529
KBYY	357	111.937	-1224.526
KOSA	358	189.947	-761.973
KPYX	359	-333.955	-390.158
KT82	360	-184.545	-1081
KPVW	361	-432.871	-634.402
K25R	362	-114.5	-1509.609
K5T5	363	-9.437	-877.587
KE38	364	-643.74	-1043.615
KF05	365	-209.141	-635.991
KGYI	366	30.479	-695.167
KHHF	367	-304.913	-447.807
KHQZ	368	43.967	-802.91
KJSO	369	168.422	-899.337
KJWY	370	8.451	-835.284
KLBR	371	179.475	-707.745
KLUD	372	-53.902	-747.262
KSNK	373	-369.685	-801.662
KT53	374	-68.769	-1358.77
KRPH	375	-145.239	-761.747

ATTACHMENT D

CALPUFF Control File Inputs

Group	Paramater	Description	CALPUFF Input	Default	Comments	Source
1	METRUN	Control parameter for running all periods in met. File (0=no; 1=yes)	0	0		1
	IBYR	Starting year of the CALPUFF run	2002	N.A.	2001 and 2003 are the other years modeled	1
	IBMO	Starting month	1	N.A.		1
	IBDY	Starting day	1	N.A.		1
	IBHR	Starting hour	0	N.A.		2
	XBTZ	Base time zone	0	N.A.	Greenwich Mean Time	2
	IRLG	Length of the run (hours)	8760	N.A.	2001=8760hrs, 2003=8748hrs only 12 hrs on 12/31	1
	NSPEC	Total number of species modeled	9	5	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10. To improve accuracy of analysis, provided more refined speciation of PM.	2
	NSE	Number of species emitted	9	3	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10. To improve accuracy of analysis, provided more refined speciation of PM.	2
	METFM	Meteorological data format	1	1	CALMET unformatted file	1
	AVET	Averaging time (minutes)	60	60		1
	PGTIME	Averaging time (minutes) for PG - σ	60	60		1
2	MGAUSS	Control variable determining the vertical distribution used in the near field	1	1	Gaussian	1
	MCTADJ	Terrain adjustment method	3	3	Partial plume path adjustment	1
	MCTSG	CALPUFF sub-grid scale complex terrain module (CTSG) flag	0	0	CTSG not modeled	1
	MSLUG	Near-field puffs are modeled as elongated "slugs"?	0	0	No	1
	MTRANS	Transitional plume rise modeled?	1	1	Transitional plume rise computed	1
	MTIP	Stack tip downwash modeled?	1	1	Yes	1
	MBDW	Method used to simulate building downwash?	1	1	ISC method	1
	MSHEAR	Vertical wind shear above stack top modeled in plume rise?	0	0	No	1
	MSPLIT	Puff splitting allowed?	1	0	1=Yes	2
	MCHEM	Chemical mechanism flag	1	1	Transformation rates computed internally (MESOPUFF II scheme)	1
	MAQCHEM	Aqueous phase transformation flag	0	0	Aqueous phase not modeled	1
	MWET	Wet removal modeled?	1	1	Yes	1
	MDRY	Dry deposition modeled?	1	1	Yes	1
	MDISP	Method used to compute dispersion coefficients	3	3	PG dispersion coefficients in RURAL & MP coefficients in urban areas	1
	MTURBVW	Sigma-v/sigma theta, sigma-w measurements used?	3	3	Use both sigma-(v/theta) and sigma-w from PROFILE.DAT Note: not provided	1
	MDISP2	Backup method used to compute dispersion when measured turbulence data are missing	3	3	PG dispersion coefficients in RURAL & MP coefficients in urban areas	1
	MROUGH	PG sigma-y,z adj. for roughness?	0	0	No	1
	MPARTL	Partial plume penetration of elevated inversion?	1	1	Yes	1
	MTINV	Strength of temperature inversion	0	0	No	1
	MPDF	PDF used for dispersion under convective conditions?	0	0	No	1
	MSGTIBL	Sub-Grid TIBL module used for shoreline?	0	0	No	1
	MBCON	Boundary conditions (concentration) modeled?	0	0	No	1
	MFOG	Configure for FOG model output	0	0	No	1
	MREG	TEST options specified to see if they conform to regulatory values?	1	1	Checks made	1
3	CSPEC	Species modeled	SO2, SO4, NOX, HNO3, NO3, EC, OC (SOA), PM25, PM10	N.A.		2

Group	Paramater	Description	CALPUFF Input	Default	Comments	Source
4	PMAP	Map projection	LCC	Lat Long	Used Lambert conformal conic per CENRAP guidance	1
	FEAST	False Easting	0	0		1
	FNORT	False Northing	0	0		1
	RLATO	Latitude	40N	N.A.		1
	RLONG	Longitude	97W	N.A.		1
	XLAT1 XLAT2	Matching parallel(s) of latitude for projection	33N 45N	N.A.		1
	DATUM	Datum region for the coordinates	WGS-G		WGS-84 GRS 80 spheroid, global coverage (WGS84)	1
	NX NY NZ	Meteorological grid No. X grid cells in meteorological grid No. Y grid cells in meteorological grid No. vertical layers in meteorological grid	306 246 10	N.A.		1
	DGRIDKM	Grid spacing (km)	6	N.A.		1
	ZFACE	Cell face heights (m)	0, 20, 40, 80, 160, 320, 640, 1200, 2000, 3000, 4000	N.A.		1
	XORIGKM YORIGKM	Reference coordinates of SW corner of grid cell (1,1) (km)	-1008 -1620	N.A.		1
	IBCOMP JBCOMP IECOMP JECOMP	Computational grid X index of LL corner Y index of LL corner X index of UR corner Y index of UR corner	199 73 306 192	N.A.		1
	LSAMP IBSAMP JBSAMP IESAMP JESAMP MESHDN	- Logical flag indicating if gridded receptors are used - X index of LL corner - Y index of LL corner - X index of UR corner - Y index of UR corner - Nesting factor of the sampling grid	F 1	F	Receptors are only in the Class I areas assessed	1
5	SPECIES	Species (or group) list for output options	1	0	Concentrations saved for SO2, SO4, NOx, HNO3, NO3, EC, SOA, PM25, PM10	1
6	NHILL	Number of terrain features	0	0		1
	NCTREC	Number of special complex terrain receptors	0	0		1
	MHILL	Terrain and CTSG receptor data for CTSG hills input in CTDM format?	2	N.A.	Hill data created by OPTHILL & input below in subgroup (6b); receptor data in subgroup (6c) note: no data provided	1
	XHILL2M	Factor to convert horizontal dimensions to meters	1	1		1
	ZHILL2M	Factor to convert vertical dimensions to meters	1	1		1
	XCTDMKM	X-origin of CTDM system relative to CALPUFF coordinate system, in Km	0	N.A.		1
	YCTDMKM	Y-origin of CTDM system relative to CALPUFF coordinate system, in Km	0	N.A.		1
7	SPECIES DIFFUSVTY ALPHA STR REACTVTY MESO RES HENRYS C	Chemical parameters for dry deposition of gases	SO2 NOX HNO3 .1509 .1656 .1628 1000 1 1 8 8 18 0 5 0 .04 3.5 8.0*E-8	SO2 NOX HNO3 .1509 .1656 .1628 1000 1 1 8 8 18 0 5 0 .04 3.5 8.0*E-8		1
8	SPECIES GEO. MASS DIA. GEO. SDEV.	Single species: mean and standard deviation used to compute deposition velocity for NINT size-ranges; averaged to obtain mean deposition velocity. Grouped species: size distribution specified, standard deviation as "0". Model uses deposition velocity for stated mean	SO4,NO3, EC, SOA, PM10, PM25 0.48 micron (all species) 2 microns (all species)	SO4,NO3, EC, SOA, PM10, PM25 0.48 micron (all species) 2 microns (all species)		1,2
9	RCUTR	Reference cuticle resistance	30	30		1
	RGR	Reference ground resistance	10	10		1
	REACTR	Reference pollutant reactivity	8	8		1
	NINT	Number of particle-size intervals to evaluate effective particle deposition velocity	9	9		1
	IVEG	Vegetation state in unirrigated areas	1	1		1
10	SPECIES LIQ. PRECIP. FROZ. PRECIP.	Scavenging coefficients	LIQ FROZ SO2: 3E-5 0 SO4: 1E-4 3E-5 NOX: 0 0 HNO3: 6E-5 0 NO3: 1E-4 3E-5 EC: 1E-4 3E-5 SOA: 1E-4 3E-5 PM10: 1E-4 3E-5 PM25: 1E-4 3E-5	LIQ FROZ SO2: 3E-5 0 SO4: 1E-4 3E-5 NOX: 0 0 HNO3: 6E-5 0 NO3: 1E-4 3E-5 EC: 1E-4 3E-5 SOA: 1E-4 3E-5 PM10: 1E-4 3E-5 PM25: 1E-4 3E-5		1,2
	MOZ	Ozone data input option	1	0		2

Group	Paramater	Description	CALPUFF Input	Default	Comments	Source
11	BCKO3	Monthly ozone concentrations	40 (12 months)			2
	BCKNH3	Monthly ammonia concentrations	3 (12 months)			1
	RNITE1	Nighttime SO2 loss rate	0.2	0.2		1
	RNITE2	Nighttime Nox loss rate	2	2		1
	RNITE3	Nighttime HNO3 formation rate	2	2		1
	MH2O2	H2O2 data input option	1	1		1
	BCKH2O2	Monthly H2O2 concentrations	-	-	MQACHEM = 0; not used	1
	BCKPMF OFRAC VCNX	Secondary Organic Aerosol options	-	-	MCHEM = 1; thus, not used	1
12	SYTDEP	Horizontal size of puff beyond which time-dependent dispersion equations (Heffter) are used	550	550		1
	MHFTSZ	Switch for using Heffter equation for sigma z as above	0	0		1
	JSUP	Stability class used to determine plume growth rates for puffs above boundary layer	5	5		1
	CONK1	Vertical dispersion constant for stable conditions	0.01	0.01		1
	CONK2	Vertical dispersion constant for neutral/unstable conditions	0.1	0.1		1
	TBD	Factor determining transition-point from Schulman-Scire to Huber-Snyder building downwash scheme	0.5	-	No building downwash used	1
	IURB1 IURB2	Range of land use categories for which urban dispersion is assumed	10 19	-	METFM=1; not used	1
	ILANDUIN	Land use category for modeling domain	20	-	METFM=1; not used	1
	ZOIN	Roughness length (m) for modeling domain	0.25	-	METFM=1; not used	1
	XLAIIN	Leaf area index for modeling domain	3	-	METFM=1; not used	1
	ELEVIN	Elevation above sea level	0	-	METFM=1; not used	1
	XLATIN	Latitude (degrees) for met location	-	-	METFM=1; not used	1
	XLONIN	Longitude (degrees) for met location	-	-	METFM=1; not used	1
	ANEMHT	Anemometer height (m)	10	-	METFM=1; not used	1
	ISIGMAV	Form of lateral turbulence data in PROFILE.DAT	1	1	Read sigma-v	1
	IMIXCTDM	Choice of mixing heights	-	-	METFM=1; not used	1
	XMXLEN	Maximum length of a slug	1	1		1
	XSAMLEN	Maximum travel distance of a puff/slug during one sampling step	1	1		1
	MXNEW	Maximum number of slugs/puffs released from one source during one time step	99	99		1
	MXSAM	Maximum number of sampling steps for one puff/slug during one time step	99	99		1
	NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2	2		1
	SYMIN	Minimum sigma y for a new puff/slug	1	1		1
	SZMIN	Minimum sigma z for a new puff/slug	1	1		1
	SVMIN SWMIN	Default minimum turbulence velocities sigma-v and sigma-w for each stability class	.5 .5 .5 .5 .5 .5 .2 .12.08 .06 .03 .016	.5 .5 .5 .5 .5 .5 .2 .12.08 .06 .03 .016		1
	CDIV	Divergence criterion for dw/dz across puff used to initiate adjustment for horizontal convergence	0, 0	0, 0		1
	WSCALM	Minimum wind speed allowed for non-calm conditions. Used as minimum speed returned when using power-law extrapolation toward surface	0.5	0.5		1
	XMAXZI	Maximum mixing height (m)	4000		Top interface in CALMET simulation	1
	XMINZI	Minimum mixing height (m)	20			1
	WSCAT	Default wind speed classes	1.54 3.09 5.14 8.23 10.80	1.54 3.09 5.14 8.23 10.80		1
	PLXO	Default wind speed profile power-law exponents for stabilities 1-6	.07 .07 .10 .15 .35 .55	.07 .07 .10 .15 .35 .55		1
	PTGO	Default potential temperature gradient for stable classes E, F (deg k/m)	.020 .035	.020 .035		1
	PPC	Default plume path coefficients for each stability class	.5 .5 .5 .5 .35 .35	.5 .5 .5 .5 .35 .35		1
	SL2PF	Slug-to-puff transitions criterion factor equal to sigma-y/length of slug	10	10		1
	NSPLIT	Number of puffs that result every time a puff is split	3	3	May vary with simulation period (either 1, 2, or 3)	1
	IRESPLIT	Time of day when split puffs are eligible to be split once again; this is typically set once per day, around sunset before nocturnal shear develops	Hour 18 = 1, All others = 0			1

Group	Paramater	Description	CALPUFF Input	Default	Comments	Source
	ZISPLIT	Split is allowed only if last hour's mixing height (m) exceeds a minimum value	100	100		1
	ROLDMAX	Split is allowed only if ratio of last hour's mixing ht to the maximum mixing ht experienced by the puff is less than a maximum value	0.25	0.25		1
	NSPLITH	Number of puffs that result every time a puff is split	5	5		1
	SYSPLITH	Minimum sigma-y of puff before it may be split	1	1		1
	SHSPLITH	Minimum puff elongation rate due to wind shear, before it may be split	2	2		1
	CNSPLITH	Minimum concentration of each species in puff before it may be split	1E-7	1E-7		1
	EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	1E-4	1E-4		1
	EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-6	1E-6		1
	DSRISE	Trajectory step-length (m) used for numerical rise integration	1	1		1
	HTMINBC	Minimum height (m) to which BC puffs are mixed as they are emitted. Actual height is reset to the current mixing height at the release point if greater than this minimum	500	500		1
	RSAMPBC	Search radius (in BC segment lengths) about a receptor for sampling nearest BC puff. BC puffs are emitted with a spacing of one segment length, so the search radius should be greater than 1	10			1
	MDEPBC	Near-surface depletion adjustment to concentration profile used when sampling BC puffs?	1	1	Adjust concentration for depletion	1
13	NPT1	Number of point sources with parameters	13	N.A.		2
	IPTU	Units used for point source emissions	1	1		1
	NSPT1	Number of source-species combinations with variable emissions scaling factors	0	0		1
	NPT2	Number of point sources with variable emission parameters provided in external file	0	N.A.		1
17	NREC	Number of non-gridded receptors	120	N.A.	40 Breton 80 Caney Creek	1,2

Notes:

[1] LDEQ, Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Louisiana, February 2007

[2] User-specified input based on CENRAP guidance (CENRAP BART Modeling Guidelines, December 2005)

ATTACHMENT E

POSTUTIL Control File Inputs

Group	Paramater	Description	POSTUTIL Input	Default	Comments	Source
1	ISYR	Starting year	2002	N.A.	2001 and 2003 also modeled	1
	ISMO	Starting month	1	N.A.		1
	IDY	Starting day	1	N.A.		1
	ISHR	Starting hour	0	N.A.	CALMET and CALPUFF in GMT; therefore, starting hour of POSTUTIL must correspond to 0 GMT	2
	NPER	Number of periods to process	8760	N.A.	2001=8760 hrs, 2003=8748 hrs (only 12 hrs on 12/31)	1
	NSPECINP	Number of species to process from CALPUFF runs	9	N.A.	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10	2
	NSPECOUT	Number of species to write to output file	9	N.A.	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10	2
	NSPECCMP	Number of species to compute from those modeled	0	N.A.		1
	MDUPLCT	Stop run if duplicate species names found?	0	0		1
	NSCALED	Number of CALPUFF data files that will be scaled	0	0		1
	MNITRATE	Re-compute the HNO3/NO3 for concentrations?	1	N	Yes, for all sources combined	1
	BCKNH3	Default ammonia concentrations used for HNO3/NO3 partition	-	N	12*3	1
2	ASPECI	NSPECINP species will be processed	-	N.A.	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10	2
	ASPECO	NSPECOUT species will be written	-	N.A.	SO2, SO4, NOx, HNO3, NO3, EC, OC (SOA), PM25, PM10	2

Notes:

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[2] User-specified input based on CENRAP guidance (CENRAP BART Modeling Guidelines, December 2005)

ATTACHMENT F

CALPOST Control File Inputs

Group	Paramater	Description	CALPOST Input	Default	Comments	Source
	METRUN	Option to run all periods found in met files	0	0	Run period explicitly defined	1
	ISYR	Starting year	2002	N.A.	2001 and 2003 also modeled	1
	ISMO	Starting month	1	N.A.		1
	IDY	Starting day	1	N.A.		1
	ISHR	Starting hour	0	N.A.	CALMET, CALPUFF, and POSTUTIL in GMT; therefore, CALPOST run must correspond to 0 GMT	2
	NHRS	Number of hours to process	8760	N.A.	2001=8760 hrs, 2003=8748 hrs (only 12 hrs on 12/31)	1
	NREP	Process every hour of data?	1	1	Every hour processed	1
	ASPEC	Species to process	VISIB	N.A.	Visibility processing	1
	ILAYER	Layer/deposition code	1	1	CALPUFF concentration	1
	A,B	Scaling factors X(new)=X(old)*A+B	0,0	0,0		1
	LBACK	Add hourly background concentrations/fluxes?	F	F		1
	MSOURCE	Option to process source contributions	0	0		1
	LG LD	Gridded receptors processed? Discrete receptors processed?	F T	N/Y	Receptors located only in the Class I areas assessed	1
	LCT	CTSG Complex terrain receptors processed?	F	F		1
	LDRING	Report results by DISCRETE receptor RING?	F	F		1
	NDRECP	Flag for all receptors after the last one assigned is set to "0"	1	1		2
	IBGRID JBGRID IEGRID JEGRID	Range of gridded receptors	-1 -1 -1 -1	-1 -1 -1 -1	When LG=T entire grid processed if all = -1	1
	NGONOFF	Number of gridded receptor rows provided to identify specific gridded receptors to process	0	0		1
	BTZONE	Base time zone for the CALPUFF simulation	0	N.A.	Greenwich Mean Time	2
	MFRH	Particle growth curve f(RH) for hygroscopic species	2	2	FLAG (2000) f(RH) tabulation. Note: not used	1
	RHMAX	Maximum relative humidity (%) used in particle growth curve	95	98	Doesn't matter, not used	1
1	LVSO4 LVNO3 LVOC LVPMC LVPMF LVEC	Modeled species to be included in computing light extinction	T T T T T T	T T T T T T		1,2
	LVBK	Include BACKGROUND when ranking for TOP-N, TOP-50, and exceedance tables?	T	T		1
	SPECPMC SPECPMF	Species name used for particulates in MODEL.DAT file	PM10 PM25	N N		1
	EEPMC EEPMF	Modeled particulate species	0.6 1.0	Y Y		1
	EEPMCBK	Background particulate species	0.6	Y		1
	EESO4 EENO3 EEOC EESOIL EEEC	Other species	3.0 3.0 4.0 1.0 10	Y Y Y Y Y		1
	LAVER	Background extinction computation	F	Y		1
	MVISBK	Method used for background light extinction	6	N	Compute extinction from speciated PM measurements. FLAG RH adjustment factor applied to observed and modeled sulfate and nitrate.	1
	RHFAC	Extinction coefficients for hygroscopic species (modeled and background). Monthly RH adjustment factors.	-	N.A.	See Table 4 in main protocol document	1
	BKSO4 BKNO3 BKPMC BKOC BKSOIL BKEC	Monthly concentrations of ammonium sulfate, ammonium nitrate, coarse particulates, organic carbon, soil and elemental carbon to compute background extinction coefficients	-	N.A.	See Table 5 in main protocol document	1
	BEXTRAY	Extinction due to Rayleigh scattering (1/Mm)	10	Y		1
	IPRTU	Units for all output	3	N	micrograms/cubic meter	1
	L24HR	Averaging time reported	T	N.A.		1
	LTOPN	Visibility: Top "N" table for each averaging time selected.	F	Y		1
	NTOP	Number of "Top-N" values at each receptor selected (NTOP must be <=4)	4	Y		1
	MDVIS	Output file with visibility change at each receptor?	0	Y	Create file of DAILY (24 hour) delta-deciview. Grid model run.	1

Notes:

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[2] User-specified input based on CENRAP guidance (CENRAP BART Modeling Guidelines, December 2005)

ATTACHMENT G

Modeling Archive